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2nd INTERNATIONAL CONGRESS ON CANNED FOODS

PARIS, OCTOBER 16-19, 1951

organized by the

PERMANENT INTERNATIONAL COMMITTEE ON CANNED FOODS

(Comité International Permanent de la Conserve - C. I. P. C.)

General Secretariat : 25, rue du Général-Foy, Paris, 8ème

HONORARY COMMITTEE

The Minister for Foreign Affairs, the Minister for Industry and Power, the Minister for Commerce and Foreign Economic Relations, the Minister for Agriculture, the Minister for Public Health and Population, the Minister for Merchant Marine, H.E. the Ambassador of the Argentine, H.E. the Ambassador of Belgium, H.E. the Ambassador of Denmark, H.E. the Ambassador of the Netherlands, H.E. the Ambassador of Norway, H.E. the Ambassador of Portugal, H.E. the Ambassador of Spain, H.E. the Ambassador of Sweden, H.E. the Ambassador of Uruguay, H.E. the Minister of Finland, H.E. the Minister of Switzerland.

COMMITTEE OF PATRONS

Argentina

- Junta Nacional de Carnes (National Meat Association).

Belgium

- Fédération nationale des Fabricants de Conserves de Viandes (National Meat Canners Federation).
- Groupement des Fabricants de Confitures, Pâtes de Pommes, Conserves de Fruits et Fruits confits (Association of Manufacturers of Jams, Apple Pastes, Canned Fruit and Candied Fruit).
- Groupement des Fabricants de Conserves de Légumes de Belgique (Belgian Vegetables Canners Association).
- Groupement des Fabricants d'Emballages métalliques légers de Belgique (Belgian Association of Manufacturers of Light Metal Containers).
- Groupement des Industries du Poisson (Fish Industries Association).
- Institut national pour l'Amélioration des Conserves de Légumes (National Institute for the Improvement of Canned Vegetables).

Denmark

- Fiskeriministeriets Forsøgslaboratorium (Research Laboratory of the Ministry of Fisheries).

Finland

- Finska Fiskeri A/B.

France

Metropilitan France :

- Chambre syndicale des Forges productrices de Fer-blanc et de Fer-noir (Tinplate and Blackplate Mills Committee).
- Confédération des Industries de Traitement des Produits des Pêches maritimes (Confederation of Industries for the Processing of Sea Fishery Products).
- Fédération nationale de l'Industrie de la Salaison, de la Charcuterie en Gros et des Conserves de Viandes (National Federation of the Salting and Curing, Wholesale Pork-butchery and Meat Canning Industry).
- Fédération nationale des Syndicats de Conserveurs de Produits agricoles (National Federation of Agricultural Produce Canners' Associations).
- Syndicat national des Fabricants de Boîtes, Emballages et Bouchages métalliques (National Association of Metal Container, Packing and Closure Manufacturers).
- Union des Syndicats français des Fabricants de Conserves de Poissons (Union of French Fish Canners' Associations).
- Union nationale des Fabricants de Conserves de Fruits et de Confitures (National Union of Canned Fruit and Jam Manufacturers).

Overseas France :

- Syndicat des Fabricants de Conserves et de Salaisons d'Algérie (Association of Food Canners and Curers of Algeria).
- Syndicat général algérien de la Conserverie, Fruits et Légumes (General Association of Algerian Fruit and Vegetable Canners).

Morocco

- Chambre syndicale des Industries du Poisson du Sud du Maroc (Association of Southern Morocco Fish Processors).
- Fédération des Industries de la Conserve au Maroc (Federation of Food Canning Industries in Morocco).

Netherlands

- Ondervakgroep Visconservenfabrieken (Fish Canners' Association).
- Ondervakgroep Vleeschwaren-en Vleeschconservenfabrieken (Processed and Canned Meat Manufacturers' Association).

Norway

- Hermetikkindustriens Laboratorium (Canned Food Industry Laboratory).
- Norwegian Canners' Association.

Portugal

- Instituto Português de Conservas de Peixe (Portuguese Institute for Canned Fish).
- Junta Nacional das Frutas (National Fruit Association).

Spain

- Consorcio Nacional Almadrabero (National Association of Madrague Fishers).
- Sindicato Nacional de Frutas y Productos Horticolas. Grupo de Conservas Vegetales (National Associatio for Fruit and Horticultural Products. Canned Vegetable Section).
- Sindicato Nacional de la Pesca (National Fisheries Association).
- Uniôn de Fabricantes de Conservas de Galicia (Galician Canners' Association).

Sweden

- Aktiebolaget Plåtmanufaktur.
- Svenska Institutet for Konserveringsforskning (Swedish Institute for Food Canning Research).

Switzerland

- Association suisse des Fabriques de Conserves (Swiss Association of Food Canning Factories).

United-Kingdom

- British Food Manufacturing Industries Research Association.
- Fruit and Vegetable Canners' Association of Great Britain.
- Food Manufacturers' Federation, Inc.
- The Metal Box Company, Ltd.

International Association

- International Tin Research and Development Council.

ORGANISING COMMITTEE

President :

Mr. R.V. MANAUT, Président, Comité international permanent de la Conserve (Permanent International Committe on Canned Foods).

Members :

Messrs.

L. ALQUIER, Président, Syndicat national des Fabricants de Boîtes, Emballages et Bouchages métalliques (National Association of Metal Container, Packing and Closure Manufacturers).

H. CHEFTEL, Directeur, Laboratoire de Recherches, Etablissements J.J. Carneud et Forges de Basse-Indre.

L. de CLERVILLE, Président, Union des Syndicats français des Fabricants de Conserves de Poissons (Union c French Associations of Fish Canners).

M. FOURNIER, Président, Fédération nationale de l'Industrie de la Salaison, de la Charcuterie en Gros et de Conserves de Viandes (National Federation of the Salting and Curing, Wholesale Pork-butchery ar Meat Canning Industry).

A. FRANÇOIS-PONCET, Président, Chambre syndicale des Forges productrices de Fer-blanc et de Fer-noir (Tin plate and Blackplate Mills Committee).

W. KOUDRINE, Président, Syndicat des Conserveurs de la Région parisienne (Paris District Food Canners' Asso ciation).

P. MAINGUY, Président, Union nationale des Fabricants de Conserves de Fruits et de Confitures (Nationa Union of Canned Fruit and Jam Manufacturers).

J. RÖDEL, Président, Fédération nationale des Syndicats de Conserveurs de Produits agricoles (National Fede ration of Agricultural Produce Canners' Associations).

General-Secretary :

Mr. P. PEISSI, Secrétaire Général, Comité international permanent de la Conserve (Permanent internationa Committee on Canned Foods).

TO OUR READERS

The program of the Congress is at the same time a Table of Contents.

The title of each paper or report mentioned in this program is preceded by a number in Roman figur under which the reader will find the corresponding document in the first part of the volume (white pages by referring to the same number printed at the bottom of the pages.

The blue pages which follow contain the summaries of the discussions to which the papers submitt gave rise.

At the end of the volume will be found the resolutions adopted by the Congress.

PROGRAMME OF THE CONGRESS

OPENING

(Tuesday, October 16 - morning)

Opening speech by R.V. MANAUT, Chairman of the Organizing Committee of the 2nd International Congress on Canned Foods and of the Permanent International Committe on Canned Foods (C.I.P.C.).

FIRST MEETING

(Tuesday, October 16 - afternoon)

PRESERVED FOOD AND NUTRITION

Chairman : Professor Ch. RICHET, Member of the Académie Nationale de Médecine (France).

Secretary : J. DUROCHER, Directeur, Institut national de la Conserve (France).

I. Food preservation and world nutrition, by A.G. Van VEEN, Prof. Dr., Acting-Director, Nutrition Division, Food and Agriculture Organization of the United Nations (F.A.O.).

II. The nutritional quality of canned foods.

Part 1. The nutritive value of canned foods; a basic approach by C.G. KING, D. Sc. Scientific Director, the Nutrition Foundation (United States of America).

Part 2. Review of research on nutrient retention during canning, by L.E. CLIFCORN, D. Sc., Director of Fundamental Research, Continental Can Company (United States of America).

III. On the comparative digestibility of certain foods, fresh and canned, by M. FONTAINE, Professeur, Muséum National d'Histoire Naturelle, Laboratoire de Physiologie, and Mrs N. CANNEPIN, Ingénieur I.P.C. (France).

SECOND AND THIRD MEETINGS

(Wednesday, October 17)

TECHNICAL DEVELOPMENTS OF THE CANNING INDUSTRIES IN VARIOUS COUNTRIES SINCE THE FIRST INTERNATIONAL CONGRESS ON CANNED FOODS (October 1937)

Chairman : H. CHEFTEL, Directeur, Laboratoire de Recherches, Etablissements J.J. Carnaud et Forges de Basse-Indre (France).

Secretaries : 2nd meeting : D. REMY, Directeur, Confédération des Industries de Traitement des Produits des Pêches maritimes (France) and P. BRUAND, Secrétaire Général, Fédération nationale de l'Industrie de la Salaison, de la Charcuterie en Gros et des Conserves de Viandes (France).

3rd meeting : G. ROSKIS, Chef du Service de Documentation, Institut national de la Conserve (France).

General reports by branch of industries

IV. Twelve years' progress in the canning of fishery products, by M. JUL, Chief of the Technology branch, Fisheries Division, Food and Agriculture Organization of the United Nations (F.A.O.).

V. Technical progress in the canned meat industry, by J.P.K. van der STEUR, Chemical Department, Lever Brothers and Unilever (Netherlands).

VI. Technical progress in the vegetable canning industry throughout the world during the last 10 years, by J. DUROCHER, Directeur, and G. ROSKIS, Chef du Service de Documentation, Institut national de la Conserve (France).

VII. Development in fruit canning (1937-1951) by W.B. ADAM, Deputy Director, Fruit and Vegetable Preservation Research Station, University of Bristol (United-Kingdom).

Reports on various countries

Algeria

VIII. Developments in the canning industry in Algeria between 1938 and 1950, by F. NEAU, Etablissements J.J. Carnaud et Forges de Basse-Indre.

Australia

IX. Technological and economic advances in the Australian canning industry since 1938, by C.E. NORTON, Research Department, Southern Can Company Pty, Ltd.

Belgium

X. Technical progress in the Belgian canning industry since 1938, by P.H. LEFEBVRE, Chef des Laboratoires, Institut national pour l'Amélioration des Conserves de Légumes.

Spain

XI. The food processing industry in Spain, more especially with regard to fish, by F. LOPEZ-CAPONT, Director, Technical Services, Unión de Fabricantes de Conservas de Galicia.

Denmark

XII. Canned meat in Denmark, by C.S. LARSEN, Margarine Compagniet.

United-States of America

XIII. Technological advancement in food processing methods in the canning industry, in U.S.A., in 1940-1950, by C.O. BALL, D. Sc., Research Specialist in Food Technology, Rutgers University.

XIV. Twelve years' progress in the United States canning industry, by R.H. LUECK, D. Sc., General Manager of Research, American Can Company, and K.W. BRIGHTON, D. Sc., Supervisor, Technical Laboratory, American Can Company. (+)

France

XV. Technical progress in the French canning industry during the last 10 years, by J. DUROCHER, Directeur, and G. ROSKIS, Chef du Service de Documentation, Institut national de la Conserve.

Israël

XVI. The citrus products industries of Israel, by W. PILNIK, D. Sc., Director of Research, Central Citrus Products Research Laboratory, and M.A. JOSLYN, D. Sc.

Morocco (French)

XVII. The canning industry in Morocco, by R. MEESEMAECKER, Pharmacien-Colonel, Directeur technique des Laboratoires, Fédération des Industries de la Conserve au Maroc.

Netherlands

XVIII. The report which was anticipated under this figure when this book was planned could not be given to the Congress.

Portugal

XIX. Recent technical progress in the Portuguese canned fish industry, by H. PARREIRA, Engenheiro Chefe, Serviços Industriais, Instituto Português de Conservas de Peixe.

United-Kingdom

XX. Recent developments in fruit and vegetable canning in Great-Britain, by F. HIRST, Director, and W.B. ADAM, Deputy Director, Fruit and vegetable Research Station, University of Bristol

XXI. Developments in the fish canning industry in the United-Kingdom during the past 10 years, by J.C. HUNTLEY, Deputy Director, Research Division, Metal Box Company.

XXII. Jam canning in the United-Kingdom, recent technical developments, by Miss M. OLLIVER, M. Sc., F.R.I.C, and W.E. RHODES, M.A.

(+) This report was submitted by Berton S. CLARK, Vice-President, American Can Company.

Sweden

XXIII. Development in Sweden's canning industry, by F. JAKOBSEN, Director, Research Department, Plåtmanufaktur.

Tunisia

XXIV. The canning industry in Tunisia, by R. HAMARD, Sous-Directeur, Etablissements J.J. Carnaud et Forges de Basse-Indre.

Union of South Africa

XXV. Recent technical developments in the canning industry of the Union of South Africa, by G.G. KNOCK, D. Sc., Research Department, Metal Box Company, Ltd.

FOURTH MEETING

(Thursday, October 18 - morning)

LEGISLATION

Chairman : C.A. ADAMS, Director, Food Standards and Labelling Division, Ministry of Food (United-Kingdom).

Secretary : Ch. LAGNEAU, Directeur, Union nationale des Fabricants de Conserves de Fruits et de Confitures (France).

XXVI. Food laws and enforcement in the United-States, by C.H. BLOEDORN, Manager of Technical Services, Continental Overseas Corporation (United States of America). (+)

XXVII. Some comparisons between food legislation of various countries, by C.L. HINTON, Superintendant of Research, British Food Manufacturing Industries Research Association (United-Kingdom).

FIFTH MEETING

(Thursday, October 18 - afternoon)

Economic section

COST AND AVAILABILITY OF CANNED FOODS COMPARED WITH HOME COOKED FOODS IN VARIOUS COUNTRIES

Chairman : E. MAYOLLE, Vice-Président, Conseil national du Patronat français (France).

Secretary : J.M. RAUFASTE, Secrétaire Général, Fédération nationale des Syndicats de Conserveurs de Produits agricoles (France).

Belgium

XXVIII. Comparison of the cost and availability of canned and fresh foods, by F.H. LEFEBVRE, Chef des Laboratoires, Institut national pour l'Amélioration des Conserves de Légumes

Denmark

XXIX. Comparison between a few dishes prepared with canned food and the same dishes prepared with fresh food, by F. BRAMSNAES, Direktor, Fiskerministeriets Forsøgslaboratorium.

United-States of America

XXX. Comparative cost and availability of canned, glassed, frozen, and fresh fruits and vegetables in the United States of America, by W.A. KREHL, Ph.D., Yale Nutrition Laboratory, Department of Physiological Chemistry, Yale University School of Medicine.

(+) Following the submission of this paper Milton P. DUFFY, Chief, Bureau of Food Inspection (California) commented the enforcement of State and Federal Food Laws in the United-States of America.

France

XXXI. Comparative cost and availability of preserved and fresh foods, by G. JUMEL, Conseiller technique, Conseil Supérieur de la Conserve.

Sweden

XXXII. The cost and availability of industrial food products, as compared with home made products, in Sweden, by Mrs C. BOALT, F.M., Direktor, Hemmens Forskninginstitut, and General principles for comparing processed foods with similar home prepared dishes, by G. BORGSTRÖM, D. Sc., Direktor, Svenska Institutet for Konserveringsforskning.

Scientific section

BACTERIOLOGY OF DELIBERATELY NON-STERILE CANNED FOODS.

NON-ENZYMATIC BROWNING

Chairman : M.A. MACHEBOEUF, Chef de Service, Institut Pasteur de Paris (France).

Secretary : L. BONNET, Inspecteur technique, Institut national de la Conserve (France).

XXXIII. The bacteriology of semi-sterile fish preserves, especially "gaffelfiter" and "anchovies", by Miss V. ASCHEHOUG, Chief of the Bacteriology Department, Hermetikkindustriens Laboratorium (Norway).

XXXIV. Studies on the processing of "foie-gras", by P. FLEURET, J. DUROCHER, Miss M-L. THUILLOT, Miss C. TARDIVON, and H. CHEFTEL (France).

XXXV. Studies on the production of anchovies at the Portuguese Institute for Fish Preservation; summary based on a report by Ch. LEPIERRE (†) and a note by J. MERCIER-MARQUES, Engineering Chemist (Portugal).

XXXVI. The bacteriological examination of canned hams, by R. BUTTIAUX, Chef de Service, Institut Pasteur de Lille (France).

XXXVII. Non-enzymatic browning, by C.H. LEA, Low Temperature Station for Research in Biochemistry and Biophysics, University of Cambridge, and Department of Scientific and Industrial Research (United-Kingdom).

SIXTH MEETING

(Friday, October 19 - morning)

PACKING

Chairman : V.J. DRESCHFELD, Sales Manager, Food Cans, Metal Box Company (United-Kingdom).

Secretary : G. LECAT, Chef de Service, Etablissements J.J. Carnaud et Forges de Basse-Indre (France).

XXXVIII. Developments in tinplate technology, by E.S. HEDGES, D. Sc., Director of Research, Tin Research Institute (United-Kingdom).

XXXIX. Developments in tinplate and tinplate container manufacture in the United States during the last 12 years, by R.H. LUECK, D. Sc., General Manager of Research, American Can Company, and K.W. BRIGHTON, D. Sc., Supervisor, Technical Laboratory, American Can Company (United-States of America). (+)

XL. Developments in the manufacture of canned food containers, by F. JAKOBSEN, Director, Research Department, Plåtmanufaktur (Sweden).

XLI. Development of aluminium cans, by T. TAARLAND, Chief Chemist, Hermetikkindustriens Laboratorium (Norway).

XLII. International standardization of tins for processed foodstuffs, by G. WESTON, Technical Director, British Standards Institution (United-Kingdom).

(+) This paper was presented by Berton S. CLARK, Vice-President, American Can Company.

SEVENTH MEETING

(Friday, October 19 - afternoon)

REPORTS ON THE PERMANENT INTERNATIONAL COMMITTEE ON CANNED FOODS (C. I. P. C.)

Chairman : R.V. MANAUT, Chairman of the Permanent International Committee on Canned Foods.

Secretary : A. BARILLET, Secretary of the Permanent International Committee on Canned Foods.

XLIII. The Permanent International Committee on Canned Foods (C.I.P.C.) in the past, present and future, by R.V. MANAUT, Chairman of C.I.P.C.

XLIV. Report on the scientific and technical work of C.I.P.C., by H. CHEFTEL, Chairman of the C.I.P.C. Scientific Committee.

XLV. Report on the work of C.I.P.C. in the economic field, by P. PEISSI, Secretary-General of C.I.P.C.

DISCUSSIONS, RESOLUTIONS

OPENING SPEECH

by M. R. V. MANAUT

Chairman of the Organising Committee of the 2nd International Congress on Canned Foods and Chairman of Comité International Permanent de la Conserve

Ladies and Gentlemen,

I have the honour to open the 2nd International Congress on Canned Foods.

I am speaking both as Chairman of the Organising Committee and as Chairman of the Permanent International Committee on Canned Foods (C.I.P.C.).

It is in this two-fold capacity that, first of all, I wish to extend our most cordial greetings to Mr. PROTIN, Director of the Agricultural Produce Division in the Ministry for Agriculture whose presence here - as a representative of H.E. the Minister for Agriculture - specially shows the interest taken by the French Government in this Congress.

And it is in this same two-fold capacity that I express my gratitude to their Excellencies : the Minister for Foreign Affairs, the Minister for Industry and Power, the Minister for Commerce and External Economic Relations, the Minister for Agriculture, the Minister for Public Health and Population, the Minister for Merchant Marine, the Ambassador of the Argentine, the Ambassador of Belgium, the Ambassador of Denmark, the Ambassador of the Netherlands, the Ambassador of Norway, the Ambassador of Portugal, the Ambassador of Spain, the Ambassador of Sweden, the Ambassador of Uruguay, the Minister of Finland, the Minister of Switzerland, who, in agreeing to sit on the Committee of Honour have given our organisation an encouragement of the greatest value.

It is also in this two-fold capacity that I greet the congress members who have come in such large numbers from Australia, Austria, Belgium, Brasil, Costa Rica, Denmark, Egypt, Germany, Israel, Italy, Mauritius, the Netherlands, Nicaragua, Norway, Portugal, Spain, Sweden, Switzerland, the Union of South Africa, the United Kingdom and the United States, as well as the representatives of international organisations, - the Food and Agriculture Organization of the United Nations (FAO), the International Organisation for Standardization, and the International Tin Research and Development Council.

Of course, I do not forget the French congress members; they represent not only Metropolitan France, but also numerous countries of the French Union, producers of canned foods.

Finally, I have the pleasant duty of expressing my gratitude to all the associations which have agreed to constitute the Committee of Patronage of the Congress.

In the enlightened membership resulting from your number and your qualifications, the personalities who assumed the pleasant, but somewhat heavy task of organising this 2nd International Congress on Canned Foods will find the highest possible reward.

Although I am to talk to you about C.I.P.C. on Friday afternoon, during our last session, I feel I should remind you that C.I.P.C. was organised in order to implement the recommendations of the 1st International Congress on Canned Foods, held in Paris in 1937; its founders put it in charge of maintaining the liaison between the canning industries of the various countries and of undertaking work of an international character in connection with the canned food world.

At its inception, C.I.P.C. had been given the task, in particular, of organising periodic international congresses so as to follow up the first one which had met with considerable success. To comply with this requirement, C.I.P.C. initiated the holding of the 2nd International Congress on Canned Foods and established its programme.

You have certainly examined this programme and you will have seen that austerity is its keynote. We hope, however, that the variety of subjects to be considered during the working sessions, on the one hand, and, on the other hand, the few visits and receptions we have thought proper to insert in this programme will contribute to relieving this austeriry. We also trust that you will be cheered by the thought that while you are considering arduous problems, the ladies who have accompanied you to Paris are enjoying the autumn charm of Malmaison and Versailles, the delicate colours of Ancient Montmartre and admiring the elegance of Parisian Haute-Couture models.

Our programme of work is a heavy one and for this we must apologise. But it could not be otherwise as this congress comes after a long period during which great progress, both theoretical and practical, has been made in the canning industry. New machines have been invented, new methods have been developed, new processes have been discovered and put into practice, so that really what might be surprising is the fact that this Congress is only to last four days.

In fact, as there could be no question of keeping you in Paris any longer, the C.I.P.C. had to make a choice of subjects among all those brought to its attention.

To make a choice under such conditions, within so vast a subject-matter, is a task fraught with difficulties. The members of C.I.P.C. know that the selection to be made took a great deal more time than we had expected, so that instead of coming to Paris in May, you have come here in October; however, we must congratulate ourselves, as the weather which was bad in the spring, is fine this autumn.

At first, the C.I.P.C., in accordance with the recommendations made by its founders, - the 1937 Congress members, - had intended that this 2nd Congress should be almost entirely devoted to the work of the Permanent International Committee on Canned Foods. A draft programme, far less extensive than our present one was drawn up on this basis; but the examination made of it at C.I.P.C. meetings resulted in its being greatly expanded so that this first post-war meeting should be more interesting and attract as many members as possible. Consequently, while reserving, of course, a certain place for the activities of C.I.P.C., we entered several other items on the agenda.

Our aim will have been attained if this Second International Congress on Canned Foods proves as interesting to the canner as to the can manufacturer, to the tin-plate producer as to the scientist, to the government authorities who, for various reasons, have to deal with all our industries as to the canned food consumer.

The confidence we have in the success of this Congress, from this special point of view, is confirmed by your presence here. In fact, I can see in this room members belonging to all the categories I have just mentioned.

However, we do not feel vainglorious in this connection, as whatever may be the subjects adopted for the programme of a congress, its success is due to the valuable co-operation given by those who are qualified to deal with them.

The C.I.P.C. has found it possible to obtain many authors of papers and reports among its membership; but it has never claimed to bring together all, or even the greater number of those whose great competence has caused them to be considered as authorities in the world of canned foods. And this is why, in many cases the C.I.P.C. has deemed it proper to call on outside assistance. With very few exceptions, due only to circumstances beyond control, this outside assistance has been given us.

On behalf of the Permanent International Committee on Canned Foods of the Organising Committee of the Congress and also on behalf of all of us I wish to assure all these eminent contributors of our most heartfelt thanks.

I shall mention no names, as this list would be too long and also redundant, for the work and activity of all these men are so well known that their names are quite familiar to you.

However, I may say that Mr. Charles Wesley DUNN, Chairman of the Food Law Institute, member of the Board of Directors of the Nutrition Foundation and of the New-York Bar, was prevented at the last minute from coming to Paris. He was to have spoken to us next Thursday on "Aspects of United States law concerning Canned Foods", a subject on which he has particularly expert knowledge as he took a large part in the drafting of this legislation. Mr. C.H. BLOEDORN honoured us by agreeing at the last moment to take Mr. DUNN's place. We owe him the deepest thanks for helping us out so willingly.

The programme of the Congress having been drawn up, the necessary co-operation in introducing all the subjects having been obtained, there still remained the matter or organising the sessions by appointing Chairmen whose competence and authority would ensure the highest standard of efficiency for our proceedings.

Ladies and Gentlemen, you were certainly very pleased, on reading the detailed programme, to learn that Professor Charles RICHET, of the French National Academy of Medicine, Mr. Henri CHEFTEL, Chairman of the C.I.P.C. Scientific Committee, Mr. C.A. ADAMS, Director of the Food Standards and Labelling Division in the United Kingdom Ministry of Food, Mr. MAYOLLE, Vice-President of the "Conseil National du Patronat Français" and member of the Economic Council of the French Republic, Professor MACHEBOEUF, Departmental Head at the Pasteur Institute of Paris, and Mr. DRESCHFELD, Chairman of the C.I.P.C. Committee on Standardization of Round Cans (for fruit and vegetable products) have been kind enough to agree to preside over the various sessions of the Congress. For this we thank them, and also all those who have had the kindness to assume the delicate duties of secretaries to the meetings.

Ladies and Gentlemen, I now invite you to set to work. May the four days which are beginning leave you with the pleasantest of recollections : and may this recollection lead you to honour us again with your presence when C.I.P.C. invites you to attend the 3rd International Congress on Canned Foods in some city outside of France.

PAPERS PRESENTED

I. FOOD PRESERVATION AND WORLD NUTRITION

by A. G. Van VEEN, Prof., Dr.

Acting-Director, Nutrition Division, Food and Agriculture Organization of the United Nations

Food is a major preoccupation of mankind. The production, transportation, processing and trade of food occupies more people than any other single industry. Nevertheless the total world supply of food is still inadequate in terms of modern nutritional requirements; and its distribution is very inequitable. The situation is particularly serious in the so-called under-developed countries where over one half of the world's population live. It is necessary not only to stimulate greater production of food but also to encourage better use of available supplies through the application of the modern science of food technology. These are fields in which FAO is assisting governments to develop sound programs.

In general, products of agriculture, including animal husbandry and fisheries, have poor keeping qualities. According to Clarence BIRDSEYE, the inventor of quick frozen foods, 77 % of all foods are perishable. I do not know how he arrived at this figure. Actually, it could be said that all our foods are perishble unless they are properly cared for.

With few exceptions, foods are seldom eaten in the form in which they are harvested. They are generally processed or refined in some way or other before they reach the consumer. It is easy to appreciate why food processing and preservation now constitute one of the most important industries in the world. Only within comparatively recent times, however, has food technology been put on a sound scientific basis thus, making it possible for the old and usually experimental methods of food handling to be replaced with new and better methods which result in products having greater acceptability and higher nutritional value. Even so modern food technology is still in the developmental stage.

It is fortunate that our main foods - wheat, rice and maize - keep well with little treatment. If elaborate methods were needed for drying and storing them, they would probably never have become the basis of diets all over the world. This of course does not mean that modern food technology is not applicable to the preservation of cereals. The losses, both in terms of the amount of food and of nutritional value, which occur in the classical time honored methods of cereal processing and storage, are enormous. They are primarily due to the moisture content of the cereal, unsuitable enzymatic actions, attacks by micro-organisms, and methods of milling, insects and rodents. Through careful methods of drying and by the application of insecticides, fungicides and rodent poisons, such losses have been reduced significantly. Nevertheless the loss of bread grains and rice throughout the world in 1947 was estimated to be about 33 million tons, or enough to keep 150 million people alive for one year.

Cereals became the main food of mankind largely because of their ease of production, as compared with most other foods, and because of their good keeping qualities. However they frequently form too large a part of the diet. For example in the Far East 80 to 90% of the total calories are derived from rice alone and the consumption of protective foods (animal products such as milk, meat, eggs, fish, and vegetable products such as pulses, green leafy vegetables and fruits) is nutritionally speaking very inadequate. One of the important factors concerned with the low consumption of these foods in many underdeveloped countries is the difficulty of preserving them adequately and at a cost commensurable with the low economic levels which prevail in them.

We could of course imagine a prosperous, healthy and nutrition-minded population well fed according to modern concepts of the science of nutrition and whose diet would based on cereals and fresh protective foods. However this would be possible only in a fertile agricultural region without large cities which has a good all year around climate and which did not suffer from over population. Such regions are of course not easy to find! On the contrary the world is full of over-populated under-developed regions, large cities and industrial areas. Furthermore only few people are nutrition-minded. The result is that the supply of protective foods is one of the worlds most serious nutrition problems. Such foods do not keep well under ordinary conditions of storage and transportation and they are less easy to preserve than cereals and some other foods such as pulses and nuts. Poverty, prejudices and lack of knowledge of what constitutes a good diet are also factors which prevent a large part of the world's population from consuming sufficient quantities of protective foods. Methods of preserving such foods which will make them available at reasonable cost to large cities, industrial regions and other areas where fresh foods cannot readily be obtained all the year round is a foremost problem confronting food technologists.

I might mention here an example of the contribution which modern food technology has made to nutrition. Up until relatively a few years ago milk could be consumed only in those areas in which it was produced and from time to time it was the cause of serious and contagious disease. The only means of keeping milk for any length of time or of transporting it to other areas was by making it into cheese or butter or into fermented products. At the present time in economically high developed countries the keeping qualities of milk are enhanced by the modern methods of pasteurization, sterilization, dehydration, canning and refrigeration. Not only is milk made harmless for the consumer but it can now be stored for long periods of time and easily transported.

It has long been known that high protein foods, vegetables and fruits require much more treatment for preservation than do cereals. Such methods of preservation as drying, salting and pickling were developed long ago. Fermentation, which occured accidentally in many of these processes, proved to be of great value in the preservation of some green leafy vegetables, fruits and milk. Much has been achieved along these

lines in many countries all over the world. One must admire the many simple but rather effective preservation and processing methods without any scientific basis which were invented and used for long periods of time. It must be remembered however that these methods usually concern only a few products which are not always acceptable beyond the confines of the region in which they were developed (e.g. fish pastes and sauces, fermented soy products, fermented milks, sauerkraut etc.). New methods are needed to enable satisfactory products to be made available to more people.

You all know that so-called modern food technology began in the early 19th century and that APPERT was one of the first to introduce canning and sterilization of food. There is no need for me to go into the history of food technology. You probably know more about it than I do. During the past few decades new methods of food preservation have become enormously important in Western Europe and even more so in North America. For example, the U.S.A. is the most important food canning country in the world. At the present time two thirds of the total world supply of canned fruits is packed in the U.S. and more than 300 different types of food are put into cans. The U.S. is likewise the most important consumer of processed products. The per capita consumption of canned frozen and dried fruits and vegetables in the U.S. has increased enormously since 1920. I would like to mention just a few figures (Tables I and II).

In Table III (p. 3) you will find figures on production and consumption of canned meat in the U.S.A.

The FAO Fisheries Bulletin stated that in 1949 the following amounts of canned fish have been produced in the world.

	metric tons
Canned salmon	151,866
Canned tuna	101,084
Canned herring and allied species ...	261,879

But as it was stated in a working paper for the Fisheries Meeting held at Bergen in 1950, this large amount of canned products is really consumed by only a small portion of the world's population, and this makes it obvious that the potential consumption of canned food is enormous.

TABLE I (+)

CANNED, DRIED, AND FROZEN FRUITS AND VEGETABLES CIVILIAN CONSUMPTION PER CAPITA IN THE UNITED STATES

In pounds per year

	1920	1930	1940
Canned fruit	9.4	12.0	17.5
Canned juices	-	0.3	7.1
Dried fruit	6.5	5.3	6.3
Frozen fruit	-	0.5	1.2
Canned vegetables	19.2	29.0	35.0
Tomatoes	5.1	6.4	6.3
Corn	4.2	4.1	4.1
Peas	3.4	4.7	5.7
Other canned vegetables	6.5	13.8	18.9

(+) from : H.C. SHERMAN, Foods, their value and management New-York, 1946.

TABLE II

FOOD BALANCE SHEET UNITED STATES (+)

per caput consumption in g /day

	1935-1939	1948-1949
Vegetables		
Fresh	222.5	246.3
Canned	38.6	46.3
Frozen	0.5	3.3
Other	0.6	14.0
	262.2	309.9
Fruits		
Fresh	203	193.7
Canned	18.6	22.7
Canned juice	4.9	20.3
Dried	7.1	4.9
Frozen	0.8	3.8
	234.4	245.4

(+) FAO Food Balance Sheets

The dollar values of frozen foods in the U.S. was (on the wholesale level) in 1947, 0.35 billion dollars, in 1950 0.6 billion dollars, in 1951 probably 0.7 billion dollars. This is exclusive of the 10,000 locker plants which probably contribute another 0.2 billion dollars.

I will not give you more figures on the production or consumption of preserved protective foods.

These figures emphasize how important modern food technology can be in economically high developed countries.

World war II and its impact on the economy of Western countries stimulated the development of the modern science of food technology. It has become a popular course of study and in many centres in the U.S. in particular there are now well organized currisula on food technology. Modern food technology has brought about many alterations in food management in these countries to a very considerable extent; in fact it could almost be said that food habits are being guided to an increasing degree by the development of food technology.

In general, consumers want preserved foods to have a texture, flavor and color resembling the original fresh foods as much as possible. Acceptability research is playing an ever increasing role in the development of modern food technology. In this regard modern methods of preservation are generally far su-.

TABLE III

PRODUCTION OF CANNED MEATS IN THE U.S.A.

In million cases (48 lbs. case)

Period	Pack	Export	Import
1931-1935 (+).........	3.9	0.5	0.9
1936-1940 (+).........	8.0	0.3	1.7
1941-1945 (+).........	40.6	11.8	1.9
1946	27.0	16.2	0.1
1947	20.7	1.0	0.7
1948	23.0	0.8	3.0
1949	21.8	0.5	1.9

(+) Average of years shown.

From : Western Canner and Packer (Statistical Review and Yearbook Number), Vol.42 (7), 150, 1950.

perior to the old traditional methods. For example, the old methods of salting, pickling, drying and smoking altered the texture, flavor and color of foods considerably, and the manufacturer had little control over these changes. The consumer therefore had little choice; he had either to be content with the products or do without them. Of course some products such as certain cheeses, marinates, sauerkraut, fermented milks although having little in common with the fresh products were accepted on their own merits. A great deal of progress has been made during the last ten or twenty years in improving the nutrition quality of preserved foods. In the early days of canning a large part of the nutrients, particularly minerals and vitamins, were lost, extracted or destroyed. Much attention has been given to methods of preservation which will retain the maximum amount of nutritive value. The results so far have been very encouraging. However, I will leave this field to the next speakers, Drs. KING and CLIFCORN.

Food preservation is only one aspect of food technology which is concerned with nutrient content. By means of the well known methods of enrichment and fortification it is possible to restore the nutrients which are lost during processing. Enrichment is of course of practical value only if the foods which are enriched are stable and have good keeping qualities.

As I have mentioned, food technology has influenced modern food management to a very great extent. It has increased the efficiency of marketing foods and made wider and more equitable distribution possible. The fact that well preserved foods can now be transported anywhere is especially important in time of emergency. A striking example is the role played by the United Nations International Children Emergency Fund in furnishing dried skimmed milk and other preserved foods, to millions of children in countries where war, or certain emergencies such as earthquakes, have deprived them of adequate food.

Modern food technology has done a great deal in promoting good health. Canned frozen and dehydrated foods usually contain fewer micro-organisms than foods preserved according to classical methods. Furthermore their nutrient value is often much higher. For example foods can be canned in such a way that they retain a very large proportion of their original nutritive value and since they are practically sterile they are free of pathogenic organisms.

Probably the greatest triumph of scientific food technology can be seen when we compare modern military rations with the ones used on sailing vessels a hundred or two hundred years ago. At that time it was impossible to keep people healthy on a diet which did not contain sufficient fresh foods which were of course impossible to provide on long voyages. Now however rations which do not contain any fresh foods and which insure good health and well being for long periods of time can be provided. Such a statement is made of course realizing that the progress of science may reveal new and essential food factors which must be taken into account in planning rations. Furthermore ir is not uncommon to discover new reactions in foods which are of considerable practical importance. I am thinking for example of the reactions between proteins, amino-acids and carbohydrates or the effects of heating on the biochemical value of proteins. I think we are all aware of the limitations of our knowledge but at least we know that modern military rations can be used as the only source of food for a very long time without any detrimental influence on health or working capacity. This is an achievement which we probably would not have thought possible forty or fifty years ago.

Advances in food technology have benefited mainly the economically higher developed countries. Much is still to be achieved in the economically under-developed countries many of which are in tropical and sub tropical zones where there are special problems of production and preservation to be overcome. And these problems must be overcome if the nutrition situation in these areas is to be improved.

Crops, when harvested, and live stock when slaughtered are at once subject to attack by micro-organisms and insects and consequently spoilage. The same is of course true of fish. Such spoilage occurs more rapidly in higher temperatures. In cold climates spoilage sets in relatively slowly so that simple storage methods are often quite sufficient. High temperatures, high moisture content of the air, abundance of micro-organisms and insects are factors commonly found in tropical countries which makes spoilage a more serious problem in them than in temperate areas. Simple methods of food preservation such as drying salting, pickling and smoking have been known and practiced in tropical countries for a long time but they are generally less effective than they would be in temperate areas.

It must be realized that the modern methods of processing foods often increase their cost to the consumer. This is important in considering food processing in underdeveloped countries where economic levels are generally very low. Among the factors which influence the cost of modern processed foods are harvesting, transportation, processing, packaging and storage. In a country such as U.S.A. harvesting because of high wages for agricultural labor may be expensive. Transportation of fresh foods, often in cool or cold storage, over long distances from the agricultural areas to the large cities is also expensive. Consequently retail prices of so-called fresh foods in large cities are often high. By contrast the prices of canned foods in the same cities may be considerably lower. Proximity of canning centers to production areas helps to keep ultimate costs low. There are a number of other reasons why canned goods are often less expensives than fresh foods but I will not enumerate them here.

But what about the situation in under-developed areas ? In these at least two thirds of the population live in rural areas and for the most part they produce their own food supply. Fresh foods are therefore very cheap for the rural consumer and even when wages have to be paid for labor for harvesting or trans-

porting they are generally very low. In these countries canned foods either produced locally or imported are always more expensive than fresh foods. When raw foods are to be processed in great quantities, they generally have to be transported long distances under tropical conditions to the canning centers, so that losses are very great. In these countries where economic levels are so low, the cost of processing is relatively high and the cost of containers is very often prohibitive. The container problem is a very serious one.

The question naturally arises whether there is really a need for preserved foods in these underdeveloped countries. I have already commented on the poor diet characteristic of many of these countries, on the need for better processing and storage of cereals, and especially of protective foods, such as animal products, green vegetables and fruits. If these countries in which there is often a seasonal surplus of a certain food such as fish, vegetables and fruits, could learn to use better processing methods which would enable them to have a carryover to other seasons, their general food and nutrition situation would be improved significantly. However food problems are always linked up with economic problems.

Aside from increasing basic food production in these areas there seem to be other ways by which the enormous food problems could be solved. The first is to have a careful scientific study made of the old simple methods of food preservation such as drying, salting, pickling and smoking, taking into account such factors as foods habits, preference for certain flavors and so - forth. Great improvements in these methods could probably be made. For example the success of salting and drying fish depends on the quality of the salt and the method of processing. In many areas it would probably be easy to introduce better methods. The old methods of drying vegetables and fruits, which are still followed in many areas could be improved greatly by more modern but relatively cheap methods of dehydration making use in some cases for example of sulphur dioxide. A more careful study of what happens during the manufacture of fish pastes which are common in South East Asia might well lead to simpler methods of manufacture. Secondly is the problem of finding cheap packaging materials so that even the processed products will be within the purchasing power of the mass of the population.

Lord BOYD ORR, the great nutritionist and first Director General of FAO once said " It would be a good thing if food were considered less as a commodity to be traded and more as a first essential to better life ". There is today increasing recognition of the fact that we can only save this world, this civilization, if we try to share with our less prosperous brothers the special knowledge and special advantages which we have in the so-called western world.

The great increases in population and the higher expectation of life now found in many countries are adding to the difficulties of producing sufficient food. There are only a few ways by which food supplies can be increased, by extending the food producing areas, and here the possibilities are limited; by intensifying the production in those areas already under cultivation; by preventing waste or loss of food. Today we have been specially concerned with the last factor since a large part of food waste which occurs can be prevented by the application of good food technology. The problems of food processing in under-developed countries, of presenting waste in storage and of preserving protective foods by relatively unexpensive methods have only been partly tackled. Nevertheless, there are important problems demanding our attention. In many of the under developed countries there is often insufficient knowledge about the local and traditional food preservation methods and seldom have they been studied scientifically. The scientific study of the local variations of these simple methods which I have mentioned could doubtlessly lead to great improvements in general techniques. The immense experience collected throughout the ages in many parts of the world should not be neglected. I am thinking for example of fish pastes and fish sauces and many other products which have long been used but which are scarcely known in the western world.

I hope I have been able to show you two things. The first is how important modern food technology has become to the technically highly developed countries. The second that there is also a great need for better food preservation in the less privileged countries of this world.

II. THE NUTRITIONAL QUALITY OF CANNED FOODS

I. THE NUTRITIVE VALUE OF CANNED FOODS; A BASIC APPROACH

by C. G. KING, D. Sc., Scientific Director, The Nutrition Foundation,
(United-States of America)

II. REVIEW OF RESEARCH ON NUTRIENT RETENTION DURING CANNING

by L. E. CLIFCORN, Director, Fundamental Research, Continental Can Company
(United-States of America)

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I. THE NUTRITIVE VALUE OF CANNED FOODS; A BASIC APPROACH

The food canning industry, born of research, has been fortunate in its origin. The broad lesson from history, that an individual or a civilization grows from the experiences of challenge and response, has a good analogy in the life of a successful canning company.

The two troublesome neighbors who always seem to be in conflict are :

1) the requirement to destroy microorganisms to accomplish stability and protection against infection; and

2) the worthy opponent, a demand that the resulting food shall really nourish the consumer in addition to tempting his palate. Research furnishes a pathway to peace between these two opponents.

In the United States, we believe the phenomenal growth of the canning industry has resulted from the alert research attitude of the industry in safeguarding public health. Each decade, the consumer has become more confident that the industry is taking every reasonable care to furnish foods that meet high standards of nutritive quality in addition to meeting the immediate needs of appearance, flavor and uniformity.

It is easy to forget that so far as health is concerned, malnutrition can be just as damaging as bacteria. The process is slower, but when a man's teeth decay or fall out, or his liver, kidneys and heart fail to function, he can be just as sick as if attacked by a bug or hit by a taxicab.

The prospect of peace and prosperity in the world is dependent in large degree upon our knowledge of food. We can be sure that our capacity to meet the related human needs will be challenged in the future, as it has in the past. Nutrition which is the science of food and its relation to life and health, has been generally recognized for barely half a century. The quest for knowledge in an area so broad has been pressed forward, of necessity, on many fronts.

1. The origin of the Nutrition Foundation

One of the significant programs of research in the United States and Canada during the past decade, has been planned, directed and financed by the Nutrition Foundation, Inc., an organization wholly supported by the food and related industries. The can manufacturers support the Foundation's work, and more than half of all the larger food processors are now members.

Development of basic research and education in the science of nutrition has been the single objective of the Nutrition Foundation as clearly set forth by the Board of Trustees at its founding.

The method of attaining this objective has been chiefly one of making grants to universities and medical centers to strengthen their basic research. The Scientific Advisory Committee of the Foundation,

made up of leading biochemical and medical scientists, passes on all grants, recommending support only of those projects which seem most likely to contribute to the advancement of our knowledge of nutrition.

A factor of importance in most grants is the contribution to advanced training of young scientists who have been selected by their respective universities as men and women of notable promise.

The Foundation does not undertake applied research for its members or for others. That responsibility, we believe, rests properly with the research organizations of our supporting member companies. A close and effective liaison with food manufacturers is furnished by the Food Industries Advisory Committee, made up chiefly of the respective research directors.

The overall results which have come from this central core of exploratory research and graduate training touch many phases of life. They accomplish improvements in the health of children and adults alike. They reach in their applications from better feeding of infants to protection against the most serious degenerative diseases that afflict the aged. They guide the discovery of new nutrients and accelerate their application in day-to-day eating habits. They touch not infrequently on ration improvements for the armed services - this has been especially true of the packaged rations with varying proportions of dehydrated and canned foods. Special difficulty was encountered in the retention of vitamin B_6, pantothenic acid, folic acid and vitamin B_{12}. These are relatively new nutrients that would scarcely have been considered in human food ten years ago.

The work may be characterized briefly as achieving :

1) higher levels of human health, based upon improvements in the use of food;
2) more effective education of the public in matters of nutrition;
3) an increase in the number and qualifications of scientists who deal with the technical problems of the food industry and with the related areas of research in preventive medicine;
4) direct applications of new knowledge in terms of improved food production and manufacturing practices and,

Since the work of the Foundation is supported entirely by the food and related industries, there has resulted a growing public confidence in the industry's forthright recognition of its responsibility for leadership in protecting public health.

2. Team work

The scientist, whether in industry or elsewhere, thinks of foods primarily in terms of their content of " specific nutrients " such as vitamins, fats, carbohydrates, proteins and minerals. He seeks to evaluate their use and to predict their behavior on the basis of the properties and functions of these nutrients. His knowledge of food composition furnishes a key to improved practices.

Scientists therefore exert a constructive and growing influence within the food industry. Many of the companies in the Foundation have increased their own research budgets and personnel by 300 per cent within the past ten years, that is, from 1940 to 1950. These scientists devote their energies chiefly to applications of discoveries of a basic nature, discoveries generally made in laboratories outside the industry. Most often the initial discoveries are made in the graduate divisions of our universities. The Foundation's work is focused sharply on basic science, where the need is greatest - on the search of new information and the training of scientific personnel.

Team work and good understanding between those who work primarily in basic science and those who work in applied science, bring new benefits to the consumer - to the public - and to industry.

The canned foods industry contributes to the world's food problems in proportion to its knowledge of what must be in foods to permit growth and vigorous health in people of all ages. Knowing how to measure all the nutrients, also is basic to assuring the public of their content in specific food products. Among the recent accomplishments in canning foods of high nutritive value and extremely delicate favoring constituents, we should note canned fluid milk, canned meat for baby-foods, and canned frozen orange juice.

3. Research accomplishments

A fairly complete record of the research achievements that have resulted from the Foundation's aid to universities and medical centers is reflected in more than 700 technical publications in scientific journals. Each paper fits into the broad pattern of progress, and many are of notable, individual significance. From the total record, the following examples are cited to furnish an indication of the significance of work under way :

a) Proteins

The adult human requirement for proteins, in terms of their content of some twenty amino acids, has been established as a notable extension of earlier studies with experimental animals.

A guide to infant feeding and to the nutritional requirements of mothers, resulted from a study of the composition of mother's milk conducted by Icie Macy KOOBLER of the Children's Fund of Michigan. This study, the most comprehensive of its kind, was conducted in cooperation with L.A. MAYNARD of Cornell University and resulted in a monograph published by the National Research Council, giving a summary of all information to date on the composition of human, cow's and goat's milk.

New avenues of protein research were opened by M.S. DUNN of the University of California, through the development of improved methods of protein and amino acid analysis. The results have made possible more exact measurements, more rapid progress, and many economies in practical and theoretical studies of foods.

Basic information regarding protein formation in plants was provided by research at the University of Rochester and at the California Institute of Technology. New micro-techniques (chromatographic) were devised for separating and measuring protein fragments as they are formed.

Advances in the nutritional rating of common foods, including improved rations for the armed forces, resulted from discoveries of new relationships between amino acids and members of the vitamin B-complex, by C.A. ELVEHJEM and his associates at the University of Wisconsin. This knowledge clarified the use of food in protection against pellagra, in preventing stunted growth and in avoiding a new form of nerve injury.

Widely publicized claims for a specific amino acid, glutamic acid, as a remarkable " brain food " were shown to be not valid, in research conducted by A.C. GRIFFIN and his associates at Stanford University.

b) Carbohydrates and fats

The manner in which sugars react during their delicately adjusted burning inside living cells to furnish the major source of energy for man and animals, has been extended into important new channels by Dr. C.F. CORI, at Washington University (St. Louis). The importance of their studies to medical science was recognized in their receiving the Nobel Prize in 1947.

The origin of complex fats which accumulate in the liver, in hardened arteries and in injured kidneys was clarified by discoveries at Columbia University. This work dealt with the unburned sugar and fatty acid fragments that are converted to the waxy material, cholesterol. Eating too much is obviously one of the worst forms of malnutrition that affects western civilization.

Very interesting discoveries have been made by C.H. BEST and his associates at the University of Toronto, in relating foods, and particularly choline, to protection against degenerative diseases of the heart, liver, kidneys and arteries. Choline occurs as a common ingredient of crude fats and is present in most foods high in protein. The choline requirement is dependent, also, upon the quality and quantity of protein consumed and varies further with the vitamin B_{12} intake. A remarkable feature of Dr. BEST's discoveries was the fact that animals subjected to choline deficiency for only 3 days, showed little evidence of injury until they developed hardening of the arteries in very early adult life.

This new emphasis upon the interrelationships of the vitamins, amino acids and other nutrients, is of practical interest, because it places a firm base under the requirement to use a well balanced and varied diet.

The importance of dietary factors in retarding dental caries has been shown especially at the University of Wisconsin and at Harvard University. These carefully designed studies extend the observations in European countries during the war, in demonstrating the protective role of the diet during pregnancy and very early childhood when the teeth are being formed.

c) Minerals

An important role of cobalt has been demonstrated (as a part of vitamin B_{12}) in human and animal nutrition, including its function in curing and preventing pernicious anemia, in furnishing protection against injury to the nervous system, and as an essential factor for protein metabolism and growth.

Studies of folic acid and vitamin B_{12} in feeding pigs, chickens and turkeys, and their relation to the newly discovered value of antibiotics (e.g., penicillin, terramycin, streptomycin and aureomycin) have been reported by a number of laboratories. The impetus to use antibiotics in feeds has had a marked effect upon commercial practice and has led to preliminary tests for human feeding.

Research of this nature, of critical importance to the home life of America and to all the world, could not be carried on effectively if restricted to a short-term basis. The five year financial pattern of the Foundation's membership is a very important factor in guiding constructive accomplishments.

IN SUMMARY

Hardening of the arteries, high blood pressure, heart failure, diabetes, goiter, fatty liver, injured kidneys, excessive body weight in adults, stomach and duodenal ulcers, tooth decay, loss of teeth, underweight in children tuberculosis and anemia in all age groups - <u>these and many other diseases are acknowledged by medical and public health authorities to be in significant degree, subject to lessened occurrence by a more intelligent use of food</u>.

<u>Until more is known of the composition of food, how it functions in the body and how the respective nutrients can be measured and retained in food, manufacturers are not in a position to serve the public or themselves with full efficiency</u>.

II. REVIEW OF RESEARCH ON NUTRIENT RETENTION DURING CANNING

In the United States of America, the housewise is the greatest controlling influence of the canned food industry. Except in the rural areas she has become dependent upon food from commercial sources to supply her family table as compared with dependence upon home gardens and home canning some years ago. She buys and serves her family canned foods the year around - even during the garden harvest periods. Her choices determine what products and how many cans are sold. She usually shops for foods from a moderate budget from

which she must also supply some of her personal luxuries and movie tickets or toys for her children. In regard to the cost of canned foods, it is pleasing to note that $ 1.00 worth of canned foods based on the 1935-39 period now costs $ 1.70, while the same comparison for all foods (canned foods included) reveals a present price of $ 2.28. The American housewife demands value and quality and wants foods made by those who understand her problem of feeding and of maintaining the health of her family at a moderate cost. The canned food industry has accepted the responsibility of attaining the highest possible retention of nutrients in canned foods, and assuring those concerned with human diets, by sufficient data on the nutrient composition of canned foods, that they may be considered as nutritionally representative of the raw products from which they are prepared. A review of " The Basic Seven " developed by the U.S. Department of Agriculture (1) as a guide to proper food selection by consumers during World War II is shown in figure 1. It will be noted that canned foods are shown or could be shown in almost all of the basic seven groups.

The year 1951, marks the tenth year of the National Canners Association, Can Manufacturers Institute Nutrition Program in behalf of the American canning industry and the consumers of canned foods. Prior to this Program, as was highlighted at the National Nutrition Conference for Defense called by President Roosevelt in May 1941, there existed a need for more extensive and quantitative data on the nutritive aspects of canned foods, particularly for use by home economists, dieticians, members of the medical profession and other people engaged in diet planning or formulation, both for civilian and army purposes.

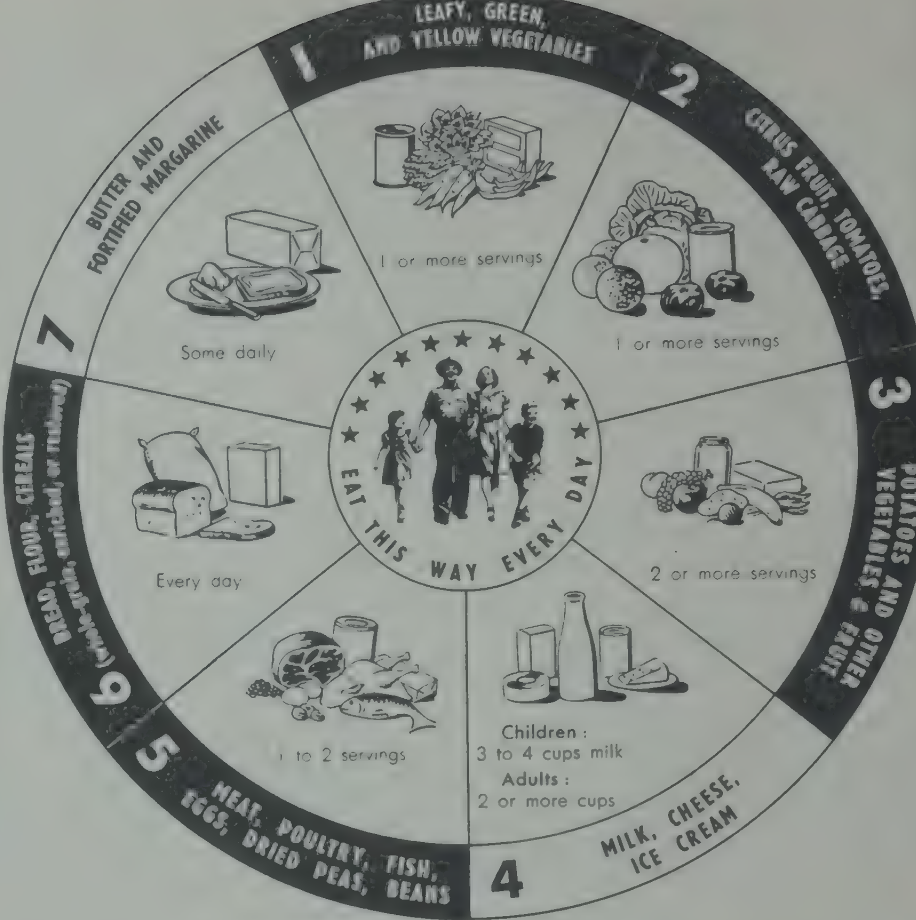

Fig. 1. The basic seven. Courtesy U.S. Department of Agriculture.

Since the early part of this century, technological progress in can manufacturing and canning and scientific progress in the field of nutrition have been rapid and most significant. From the canning of a limited number of food products in "hole and cap" cans by hand procedures in the early 1900's and a concept of nutrition then limited to proteins, fats, carbohydrates and minerals, we had progressed in 1941 to the high speed canning of a large number of food products in "open top" cans using automatic canning equipment and high speed closing machines, and to a concept of nutrition broadened to approximately 40 specific nutrients, including the vitamins. The year 1941 marked the highest production of canned foods up to that time, thus obviously showing that canned foods had assumed a very important role in the nutrition of the American people. There existed, however, in the minds of both the producers and consumers of canned foods a lack of knowledge about the vitamins, particularly with regard to their significance in canned foods. Some early reports had appeared which claimed canned foods to be devoid of the so-called vitamin B.

The studies of KOHMAN and EDDY (2) sponsored by the National Canners Association over the period 1924-1937 had produced some information on the nutritive value of canned foods as determined mainly by animal assay methods and resulted in the publication of the original and revised Bulletins 19L of the National Canners Association. With the fractionation of the originally known vitamin B into many well established entities and the development of methods for their determination, the need for further work on canned foods was clearly emphasized. It was fortunate that at the time of the inception of the NCA-CMI Nutrition Program, through basic research, some of which was sponsored by the Nutrition Foundation, Inc., many of the vitamins essential to human nutrition were known, and their properties, sources, human requirements, and convenient chemical and microbiological methods for their determination were being satisfactorily established. The " Minimum Daily Requirements of Specific Nutrients as Required by the Food and Drug Administration for the Labelling of Foods for Special Dietary Uses " (3) was published in November 1941 (table I). As a guide to improved health, the Food and Nutrition Board of the National Research Council issued in January 1943 recommended daily allowances for the various nutrients for men, women, and children (4) as shown in table II.

With this brief background we will discuss the organization and planning of the National Canners Association, Can Manufacturers Institute Nutrition Program which was initiated in 1941, and which in its ten years of existance has produced the bulk of what is known on this subject today. This program has been administered by an executive committee from the industry consisting of two members representing the Can Manufacturers Institute, Dr. F.W. PILCHER succeeded later by Dr. Randall ROYCE -- American Can Co., Dr. L.E. CLIFCORN-- Continental Can Co., Inc., and Dr. E.J. CAMERON, Dr. E.D. CLARK, and Dr. J.R. ESTY of the National Canners Association, with Dr. E.J. CAMERON as Chairman. In the early planning, the guiding principle was established, that so far as possible, actual investigations should lie in the hands of competent authorities in educational institutions well known for their work in the field of nutrition. Thus far the program has

NOTA : Figures between ( ) refer to Bibliography, p. II - 14.

received financial support, shared equally by the Can Manufacturers Institute and the National Canners Association, to the extent of about $275,000. In addition to this, special work and responsibilities which could be assumed only by laboratories connected with the canning industry were assumed by the research divisions of the Continental Can Company, the American Can Company, and the Washington and San Francisco Laboratories of the National Canners Association.

TABLE I. MINIMUM DAILY REQUIREMENTS OF SPECIFIC NUTRIENTS AS REQUIRED BY THE FOOD AND DRUG ADMINISTRATION FOR THE LABELLING OF FOODS FOR SPECIAL DIETARY USES.

Nutrients	Infants	Children 1 to 5 yrs. inclusive	Children 6 to 11 yrs. inclusive	Children 12 yrs. and over	Adults
Vitamin A (U.S.P. units)	1500	3000	3000	4000	4000
Thiamin (mg)	0.25	0.50	0.75	1	1
Ascorbic acid (mg)	10	20	20	30	30
Vitamin D (U.S.P. units)	400	400	400	400	400
Riboflavin (mg)	0.5	..	..	2.0	2.0
Calcium (g)	..	0.75	0.75	0.75	0.75
Phosphorus (g)	..	0.75	0.75	0.75	0.75
Iron (mg)	..	7.5	10	10	10

TABLE II. RECOMMENDED DAILY DIETARY ALLOWANCES (Revised 1948)

	Calories	Protein	Calcium	Iron	Vitamin A,	Thiamine	Riboflavin	Niacin (Nicotinic acid)	Ascorbic acid	Vitamin D
		mg	mg	mg	I.U.	mg	mg	mg	mg	I.U.
<u>Man</u> (154 lb., 70 kg)										
Sedentary	2400	70	1.0	12	5000	1.2	1.8	12	75	..
Physically active	3000	70	1.0	12	5000	1.5	1.8	15	75	..
With heavy work	4500	70	1.0	12	5000	1.8	1.8	18	75	..
<u>Woman</u> (123 lb., 56 kg)										
Sedentary	2000	60	1.0	12	5000	1.0	1.5	10	70	..
Moderately active	2400	60	1.0	12	5000	1.2	1.5	12	70	..
Very active	3000	60	1.0	12	5000	1.5	1.5	15	70	..
Pregnancy (latter half)	2400	85	1.5	15	6000	1.5	2.5	15	100	400
Lactation	3000	100	2.0	15	8000	1.5	3.0	15	150	400
<u>Children</u> up to 12 years										
Under 1 yr	+	++	1.0	6	1500	0.4	0.6	4	30	400
1- 3 yrs. (27 lb., 12 kg)	1200	40	1.0	7	2000	0.6	0.9	6	35	400
4- 6 yrs. (42 lb., 19 kg)	1600	50	1.0	8	2500	0.8	1.2	8	50	400
7- 9 yrs. (58 lb., 26 kg)	2000	60	1.0	10	3500	1.0	1.5	10	60	400
10-12 yrs. (78 lb., 35 kg)	2500	70	1.2	12	4500	1.2	1.8	12	75	400
<u>Children</u> over 12 years										
Girls, 13-15 yrs. (108 lb., 49 kg)	2600	80	1.3	15	5000	1.3	2.0	13	80	400
Girls, 16-20 yrs. (122 lb., 55 kg)	2400	75	1.0	15	5000	1.2	1.8	12	80	400
Boys, 13-15 yrs. (108 lb., 49 kg)	3200	85	1.4	15	5000	1.5	2.0	15	90	400
Boys, 16-20 yrs. (141 lb., 64 kg)	3800	100	1.4	15	6000	1.7	2.5	17	100	400

(+) 110/2.2 lb. (1 kg).

(++) 3.5/2.2 lb. (1 kg).

The original pattern of work which was outlined (5) consisted of two distinct phases of the program, namely :

1) determination of the specific influences or effects of commercial canning operations on the nutrients in raw canning stocks, the ultimate purpose being to improve retention of such nutrients in the final product;

2) establishment of the nutritive values of foods canned by modern practices with respect to their content of vitamins, minerals, and the proximate food components such as carbohydrate, protein and fat.

Under normal circumstances the work would have been pursued in this order, but due to the fact that the planning of the program was being carried out in the initial periods of our entry into World War II, the needs of the agencies charged with the proper nutrition of the Armed Forces required first consideration. There was an urgent demand from these agencies for exhaustive information on the composition of all types of foods, particularly with reference to vitamin content. The Food Composition Committee of the National Research Council was established as a cleaning house for all such available information. Item 2 above, the nutrient composition of canned foods, was therefore given first priority and became known as the Phase I investigations, with the work on the effect of canning operations on nutrient content following in the later years of the Nutrition Program. The vast amount of information which has been collected on the nutritive value of canned foods, besides being helpful to agencies in our Armed Forces and for civilian purposes, has been helpful to the Food and Agriculture Organization of the United Nations Nutrition Program where calculations of nutrients in large shipments of food were necessary for mass feeding purposes.

Turning now to the results of this Program, the author must first give credit to the university work resulting in 43 scientific publications from 28 university grants and the work of the industry laboratories previously mentioned for the extensive amount of basic data which has been obtained. The nutrient content of canned foods has been clearly summarized from such work in the pamphlet of the Can Manufacturers Institute, " Canned Foods in the Nutritional Spotlight " (6), and the National Canners Association publication, " Nutritive Values of Average Size Servings of Canned Foods " (7), which gives data in tabular and bar chart form on 41 nonformulated canned food products. Of particular significance, however, is the official summary publication of the results of the Phase I surveys of this Program entitled " Canned Foods in Human Nutrition " published in 1950 by the National Canners Association (5). This book has been approved and accepted by the Council on Foods and Nutrition of the American Medical Association and has a foreword written by Dr. Glen C. KING, a paragraph of which reads as follows :

" It is without doubt a great accomplishment to make available the world over a safe, attractive, " reasonably stable, low cost supply of foods in great variety. But it is a more difficult and more valuable " contribution to furnish foods that meet the body's requirements for health. Leaders in the canned foods " industry merit commendation for the thoroughness and vigor with which they have tackled the problem of " bringing modern progress in the science of nutrition to the consumer's dinner table."

Fifteen hundred copies have been printed, many of which have been distributed to individuals in this audience. In anticipation that there would be others present who would wish to have copies, the National Canners Association has sent one hundred copies for distribution here today. They are available to those who may wish to have them.

In addition to background information such as I have given you in this paper, and information on the dietary requirements of man, this book summarizes the data from the 1942 and 1943 Phase I surveys which include 1309 samples of 43 canned food products which were analyzed by five universities for carotene or vitamin A, ascorbic acid, thiamine, riboflavin, niacin, pantothenic acid, calcium, phosphorus, iron, and proximate composition. In addition, some of the newer "B" factors, namely : biotin, "folic acid" and pyridoxine were determined on the canned food products in which they might be expected to be present in significant quantities. For purposes of completeness, vitamin D assays were made on the fish products. All of the determinations were made on the total can contents. With regard to the samples, all were commercial products collected at canneries during the canning season or shortly thereafter. The samples of each product were drawn on a production ratio basis from the various geographic areas of the United States where they are grown and canned.

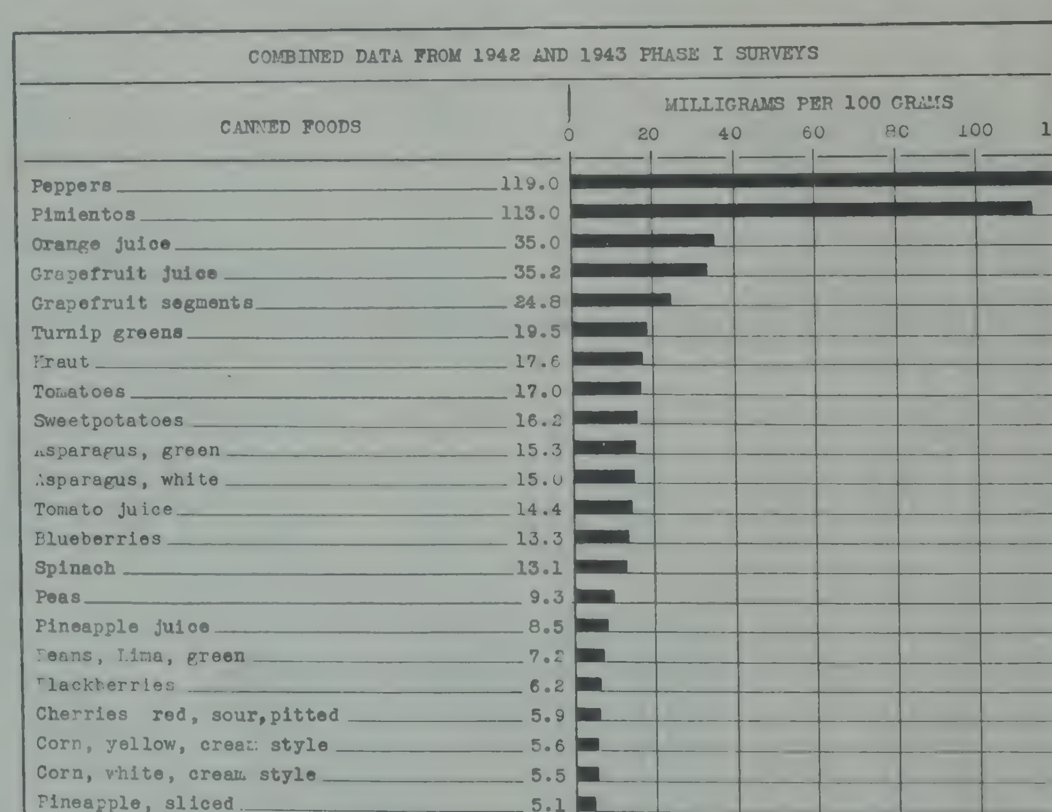

Fig. 2. The ascorbic acid content of canned foods.

From the large number of samples of each product which were analyzed for each nutrient, the range and average values of the nutrients in each product were established. figures 2 and 3 show the ascorbic acid and carotene contents of canned foods in bar chart from as represented by the average values for each specific product (6). Similar data are available for the other nutrients in the 43 canned food products analysed. Having the analytical data on nutrient composition of canned foods, the important practical consideration is the estimation of the contributions of nutrients from servings of canned foods to the daily dietary as shown in table III for ascorbic acid and carotene (5).

Due to the emphasis which has been recently placed upon the protein foods as a part of the human

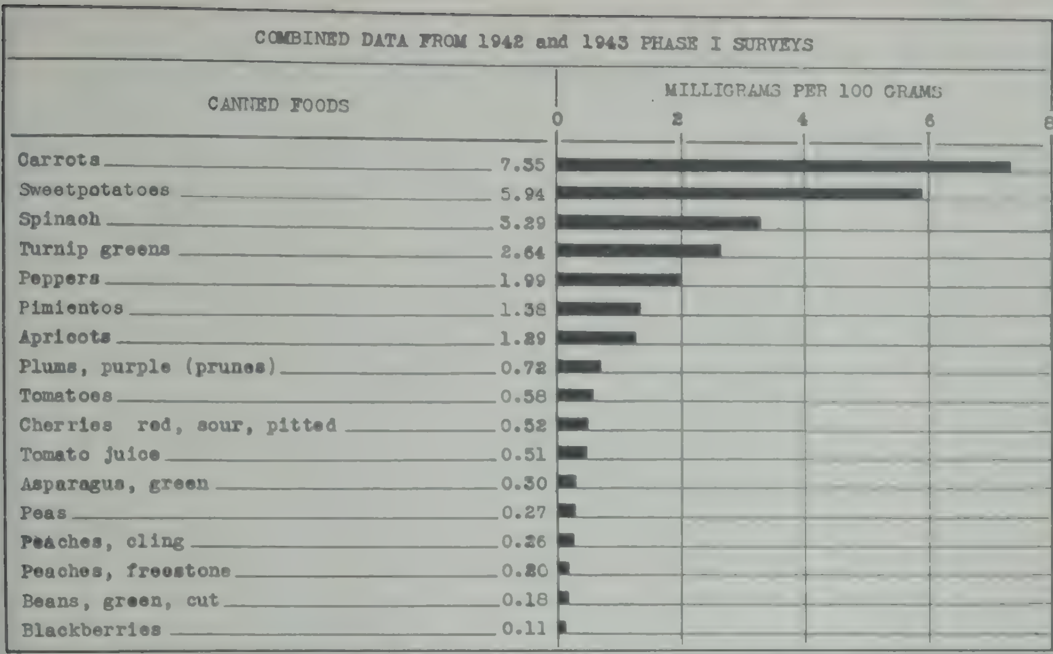

Fig. 3. Carotene content of canned foods.

diet by ROSE (8) and McLESTER (9), mention should be made here of the evaluation of the nutritive quality of protein in canned fish, meat, and peas which was sponsored by this Program.

In the work of ROSE on human subjects, it has been shown that of the twenty known amino acid components of protein, eight are indispensable or incapable of being synthesized in the body tissues and must be obtained from food sources. Early manifestations of critical deficiencies of any of these amino acids show " a profound failure in appetite, a marked increase in nervous irritability ", which may be followed by conditions of more serious and permanent body damage. It is clearly realized today that in due consideration of the vitamin era which de-emphasized many of the early findings on the proteins, fats, and carbohydrates, the first important consideration of a diet must be that it contain an adequate amount of complete protein. By complete is meant - to contain sufficient quantities of the essential amino acids to meet body requirements. These requirements for normal man have been established by ROSE (10) as shown in table IV, (page 8).

TABLE III. CONTRIBUTIONS OF ASCORBIC ACID AND CAROTENE (VITAMIN A) TO THE DAILY ADULT DIET BY SERVINGS OF VARIOUS CANNED FOOD

Product	Serving (grams)	Ascorbic acid % supplied		Carotene (Vitamin A)	
		Recommended[+]	Minimum[++]	Recommended	Minimum
Asparagus, green	108	22	55	11	14
Beans, green cut	108	5	10	6	8
Beets, cubed	113	5	17	0	0
Carrots, cubed	113	3	7	280	350
Corn, yellow, whole grain	113	7	20	3	4
Grapefruit juice	186	82	200	0	1
Kraut	108	25	65	1	1
Orange juice	186	87	230	6	8
Peaches, cling, syrup	117	6	17	10	13
Peas, sweet	113	14	37	10	13
Sweet potatoes	130	28	70	260	320
Pineapple juice	186	21	60	2	2
Spinach	102	18	43	112	140
Tomatoes	108	24	60	21	26

(+) Allowances recommended by the National Research Council.

(++) Minimum allowances of the Food and Drug Administration.

In order to show the effect of heat processing on the amino acid content of fish and meat products before and after processing, samples of the raw and canned products were assayed for the eight essential amino acids. The products included Atlantic mackerel, Pacific mackerel, fish flakes, salmon, tuna, roast beef, whole ham, and spiced ham. Table V (page 8) shows the results which were obtained for fish flakes and spiced ham (5) which are typical of the results for the other products. The excellent bar charts which were presented by Dr. E.J. CAMERON (11) in his discussion of this subject show the percent of ROSE's recommended daily intake of amino acids supplied by servings of fish. Figure 4 (page 8) which is typical of all the charts shows this information on the basis of a 100 gram serving of fish flakes.

The effect of canning on the amino acid content and biological value of the protein in peas have been studied by CHITRE, WILLIAMS and ELVEHJEM (12) and ARMBRUSTER and MURRAY (13). In both of these investigations rat feeding tests showed that the biological value of the protein in peas was not impaired by canning. The amino acid contents of the raw and the canned peas as found by CHITRE and associates (12) is shown in table VI (page 8).

TABLE IV. MINIMUM AND RECOMMENDED INTAKES OF ESSENTAL AMINO ACIDS FOR NORMAL MAN (Strictly Tentatives Values)

Amino Acid	Minimum Daily Requirement (grams)	Recommended Daily Intake (grams)
Tryptophan	0.25	0.5
Phenylalaline	1.10	2.2
Lysine	0.80	1.6
Threonine	0.50	1.0
Valine	0.80	1.6
Methionine	1.10	2.2
Leucine	1.10	2.2
Isoleucine	0.70	1.4

TABLE V. AMINO ACID CONTENT OF FISH AND MEAT PRODUCTS BEFORE AND AFTER HEAT PROCESSING (Values given as per cent of protein, N x 6.25)

Amino Acid	Fish Flakes		Spiced Ham	
	Raw	Canned	Raw	Canned
Isoleucine	5.6	5.6	4.6	4.6
Leucine	8.0	8.1	7.8	7.6
Lysine	9.0	9.1	8.5	8.0
Methionine	3.1	3.0	2.5	2.3
Phenylalaline	3.8	3.9	3.9	3.7
Threonine	5.1	5.2	4.4	4.1
Tryptophan	1.1	1.0	0.9	0.9
Valine	5.3	5.4	5.1	4.9

Since canned vegetables and fruits are almost always either brine or sirup-packed, the solid and liquid phase distribution of the water soluble nutrients is a very important consideration. It was thought that a good picture of such distribution could be obtained by the determination of ascorbic acid, thiamine, and riboflavin in the solid and liquid portions of several types of canned products. The proportions of these three vitamins in the solids and in the brine of eight different canned vegetables was determined by BRUSH et al. (14) in both consumer size and No. 10 cans, and in the solids and in the sirup of seven canned fruits in consumer size cans only. It was found that " In most canned vegetables the drained solids weight, being 60 % to 73 % of the total can contents, carried 46 % to 68 % of the ascorbic acid, 62 % to 72 % of the thiamine, and 70 % to 80 % of the riboflavin. Spinach was the outstanding exception of these ranges for with solid weights ranging from 48 % to 55 % of the total, all vitamin contents of the solid were correspondingly lower. In fruits, the solid weights of the packs showed more variation being 46 % to 67 % - with the ascorbic acid and thiamine percentages in the solid agreeing closely with the weight percentages, and riboflavin paralleling them at about 5 % to 12 % higher level". With reference to pyridoxine, biotin, and "folic acid" the distribution between the solids and the liquids has been determined by IVES et al. (15) for eight canned vegetable products. Their results show that with the solids being about two-thirds of the contents of the cans, approximately two-thirds of the pyridoxine, and 68% to 99% of the biotin were found in the solids. The two canned green vegetables found to be highest in "folic acid" contained 64 % of this factor in the solid portion.

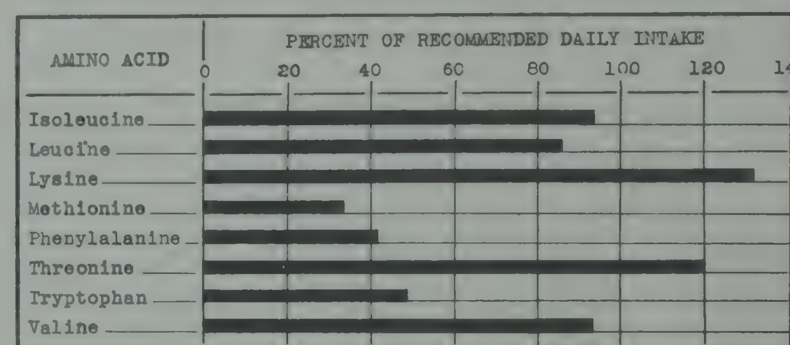

Fig. 4. Amino acids contents of average size servings of canned fish flakes.

TABLE VI. THE ESSENTIAL AMINO ACID CONTENT OF SWEET PEAS (gm % on a dry weight basis)

Amino Acid	Immature		Nearly mature peas	
	Raw	Canned	Raw	Canned
Protein =	29.6%	23.6%	27.5%	21.05%
Leucine	1.38	1.43	1.98	1.84
Phenylalaline	0.74	0.57	0.82	0.81
Tryptophan	0.20	0.22	0.20	0.20
Valine	0.91	0.80	0.91	0.80
Histidine	0.26	0.27	0.33	0.30
Lysine	0.42	0.51	0.88	0.65
Isoleucine	1.08	1.03	1.30	1.00
Arginine	2.00	1.83	2.00	1.84
Threonine	1.40	0.70	0.90	0.70
Methionine	0.18	0.23	0.22	0.20

Analyses for carotene (PRESSLEY et al. (16) on a number of canned vegetables and fruits, made on the basis of the total contents of the cans on the drained solids, have shown that the assumption that the carotene is present in the solid portion only is correct. Vitamin A assays were made on canned mackerel and tuna from which the oil has been drained in order to conform more closely to the practices of the housewife. Further work will undoubtedly show that such oil contains appreciable quantities of the fat-soluble vitamins, particularly vitamin A and some vitamin D.

Upon the suggestion of the Food and Nutrition Board of the National Research Council, work was conducted on the proximate and mineral composition of the solid and liquid portions of canned foods. Analyses were conducted by KRAMER (17) on canned asparagus, green beans, Lima beans, beets, carrots, whole kernel corn (maize), peas, and spinach. The proportion of the protein content in the liquid portion varied from

6 % to 8 %, respectively, for spinach and corn to almost 33 % for beets. Insignificant amounts of fat and fiber were found in the liquid portion. The ash content of the liquid portion was about equal to that of the solid portion. The carbohydrate fraction in the liquid portion varied considerably, from 9 % for Lima beans to well over 25 % for asparagus, beets, and carrots. The proportion of calcium in the liquid portion varied more than for any other constituent. For asparagus, Lima beans, and corn, the calcium content of the liquid portion approached that of the solid, while the amount of calcium in the liquid portion of spinach was negligible. In canned spinach and beets the phosphorus content of the liquid portion approached that of the solid portion. Iron was almost equally distributed between the solid and liquid portions of most of the canned foods studied.

The vitamin content of canned foods at the time they are eaten is the most important consideration from the standpoint of the consumer. Work has been reported by HINMAN et al. (18) (19) on the effects of various methods of preparation of canned foods for serving on their ascorbic acid, thiamine, and riboflavin contents. Home preparation methods using consumer size cans and institutional preparation using several No. 10 cans were studied. In home preparation, two methods of cooking were employed : 1) heating the total contents of the can to a boil and serving the solids only, and 2) boiling the liquid portion to one-half to one-fourth the original volume, adding the solids, bringing to a boil and serving the entire contents. In the institutional preparation, the methods were guided mainly by Army and Navy interest. The total content of several No. 10 cans were boiled for 30 minutes, after which two methods of serving were employed : 1) serving with all the liquid, and 2) serving solids with a slitted spoon. The results of this investigation (18) (19) are shown in table VII.

TABLE VII. PER CENT RETENTION OF VITAMINS AFTER PREPARATION FOR SERVING
(Original canned product - 100 %)

Vegetables	Home preparation				Institutional preparation (boiled 30')			
	Liquid concentrated		Liquid discarded		Solids and liquids		Drained solids	
	Ascorbic acid	Thiamine	Ascorbic acid	Thiamine	Ascorbic acid	Thiamine	Ascorbic acid	Thiamine
Asparagus	--	--	--	--	95	95	72	72
Beans, baked	--	--	--	--	--	90	--	--
Beans, cut green	81	98	49	61	53	92	30	60
Beans, green Lima	62	97	39	62	45	94	29	73
Carrots	41	96	--	--	40	95	72	74
Corn, yellow, whole kernel ..	50	92	37	--	32	78	7	57
Peas	51	100	30	63	--	--	--	--
Spinach	--	--	38	72	77	96	52	67
	Heated--All served				Boiled 30 mins.			
Tomatoes	97	100			97	83		

In addition to the institutional methods, holding on a steam table for one and one-half hours after preparation was also studied. Insignificant losses were observed upon such holding for asparagus and tomatoes, while significant losses were observed for some of the other vegetables. Spinach retained 87% of its ascorbic acid content. The low pH of tomatoes would explain their 92 % retention of ascorbic acid under these conditions. The one and one-half hour holding period on a steam table was not detrimental to the thiamine or riboflavin content. No information is available on the effect of such holding on the carotene or vitamin A content of canned foods.

It is believed that the above-mentioned investigations give a good cross-sectional picture of the changes taking place in the vitamin content of canned foods during preparation for serving in home kitchens and in institutional or mess hall operations. The results of this investigation showed no detrimental effects upon thiamine or riboflavin but some serious effects upon ascorbic acid in certain products.

It should be emphasized at this point that no foods are commonly prepared for the table without some sacrifice of nutrients from the raw materials due to kitchen procedures such as trimming, boiling, baking, broiling or roasting, which are necessary to make the products more edible or more acceptable. Likewise the operations in commercial milling, dehydration, freezing, canning, or other food preserving industries also may effect the nutrient composition of raw foods. In this consideration the better known vitamins, their major food sources, and their properties (20) are shown in table VIII.

TABLE VIII. SOME PROPERTIES WHICH INFLUENCE THE STABILITY OF THE BETTER KNOWN VITAMINS IN FOODS

Vitamin	Soluble in		Affected by Oxygen	Affected by Heat+	Affected by Light
	Water	Fats			
Vitamin A (Carotene and Vitamin A)	No	Yes	Yes	No	Possibly
Thiamine	Yes	No	No	Yes	No
Riboflavin	Yes	No	No	No	Yes
Niacin	Yes	No	No	No	No
Ascorbic acid	Yes	No	Yes	No+	Possibly
Vitamin D	No	Yes	Yes	No	No

(+) Assuming absence of oxygen or oxidizing substances.

These considerations are very important to those concerned with the effect of various canning operations on nutrients. In work on vitamin retention during canning a large number of "over-all" determinations from the raw to the finished canned food products have been made for the purpose of determining the products where vitamin retentions were such that further step-by-step studies of the canning operations would be justified. The results of such surveys have been expressed as percent retentions on a unit weight basis of original raw product. In the following figures showing some of the results of this work, the canned foods are treated as classes of products with no distinction as to variety or style of pack. For example, green and white asparagus whether they are whole spears or cuts are treated as asparagus. The number of over-all retention surveys varied from 4 for carotene in yellow corn to 93 on the retention of ascorbic acid in grapefruit juice. The results of some of these studies on carotene retention (21) are shown in figure 5. The numbers to the right of each bar indicate the number of over-all observations. Similarly figures 6 and 7 show over-all ascorbic acid and thiamine retentions (21). Similar studies on other products and for other nutrients are given in the paper by CAMERON et al. (22) or in the book " Canned Foods in Human Nutrition ".

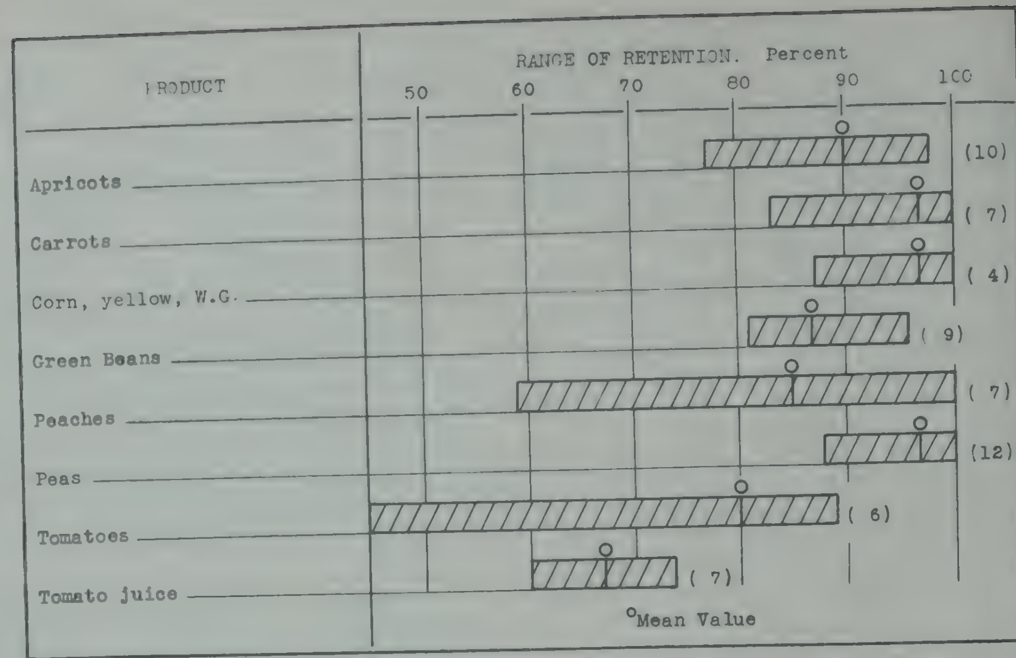

Fig. 5. Over-all carotene retentions.

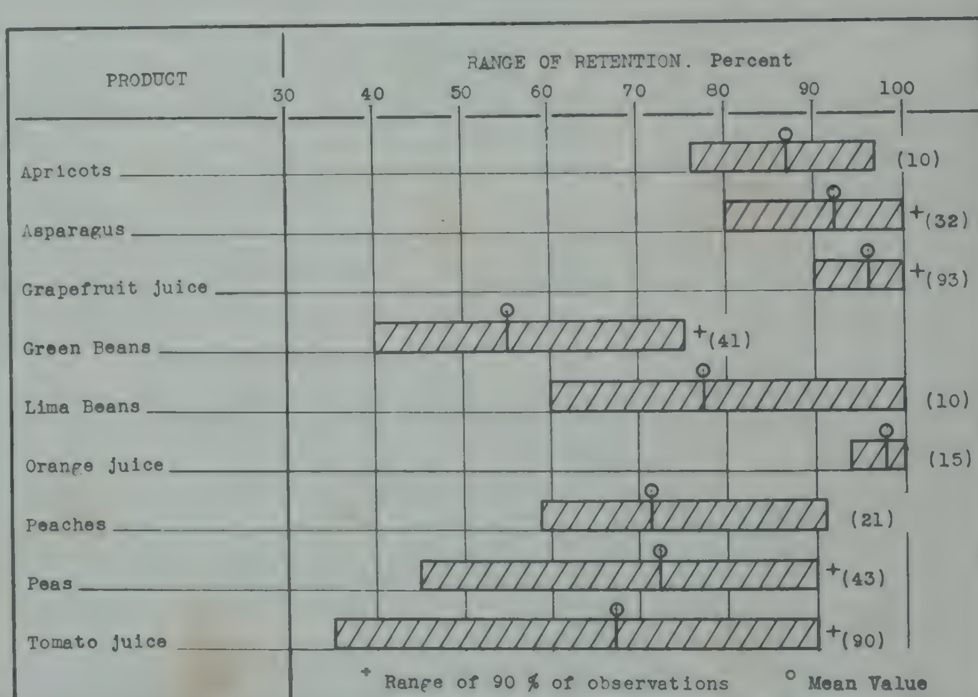

Fig. 6. Over-all ascorbic acid retentions.

In addition to studies on over-all nutrient retentions, surveys have been made of specific canning operations to determine which steps during the preparation and processing of canned food products are of most serious concern. Such step-by-step studies have revealed that blanching required in the canning of certain products results in sacrifice of vitamin content, particularly due to the leaching effect on the water-soluble vitamins. Figures 8 and 9 (p. 11 and 12) show the ascorbic acid and thiamine retentions during blanching (21), summarized from number of surveys indicated for the specific vegetables. Information on riboflavin and niacin retentions are given in the references last cited.

Since blanching is an operation of major concern in vitamin retention in certain canning operations, it has been the subject of considerable study (23) (24) (25). FEASTER et al. (24) found that by changing the time of the rotary drum type blanch for peas from 18.5 minutes at 190° to 200°F, to 4.5 minutes, no difference in the quality characteristics of the peas could be observed, while a significant increase in retention of ascorbic acid and thiamine was produced in the final canned product, particularly for standard sweet peas as shown in figure 10, page 13.

The heat labile properties of thiamine raise the question as to retention of this vitamin during heat sterilization of canned foods. Other nutrients seam to be little affected by this operation. Thiamine retentions as observed during the thermal processing of several vegetable products (5) are shown in table IX, page 11. With respect to improved quality and improved retention of heat labile factors such as thiamine the tendency of the canning industry is to go to high-temperature, short-time processes - as far as practical in still retorts and also with new types of agitating cookers and aseptic canning units employing tubular sterilizers (26). The advantages of high-temperature, short-time processes, may be observed in figure 11 (page 13) which shows the comparative rates of thiamine retention in peas as affected by bacteriologically equivalent processing times and temperatures (26). Table X (page 12) shows a comparison of thiamine retention of agitated high-temperature processed versus conventionally processed peas and corn (26). The adoption of high-temperature, short-time processes for canned foods would enhance their thiamine content considerably.

Under the usual storage conditions canned foods show an excellent degree of stability against loss of quality (acceptability as food) or nutritive value. For maximum retention of quality and nutritive value, canned foods should be stored under cool conditions, and if under elevated temperatures for as short a time

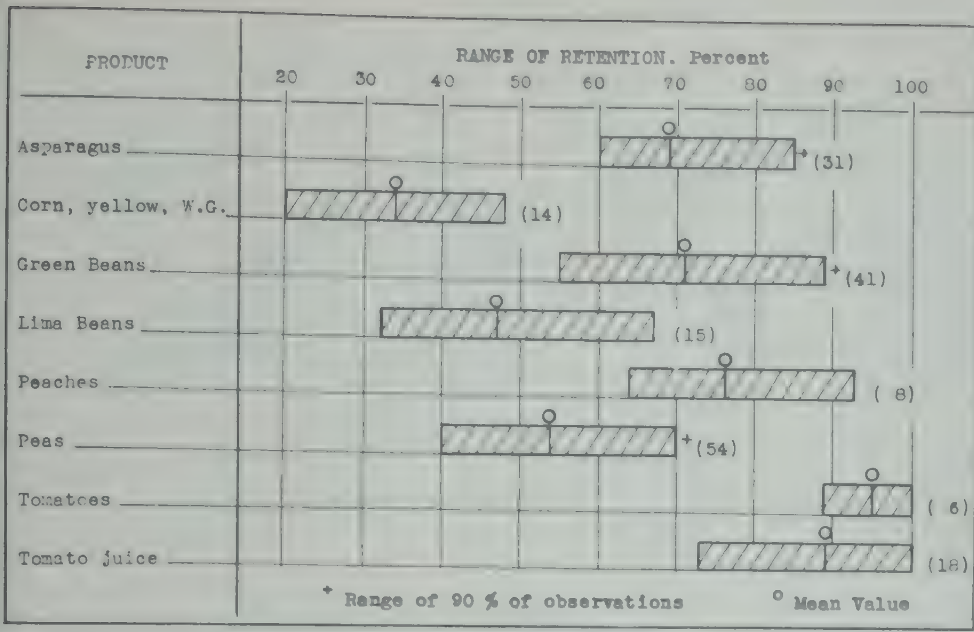

Fig. 7. Over-all thiamine retentions.

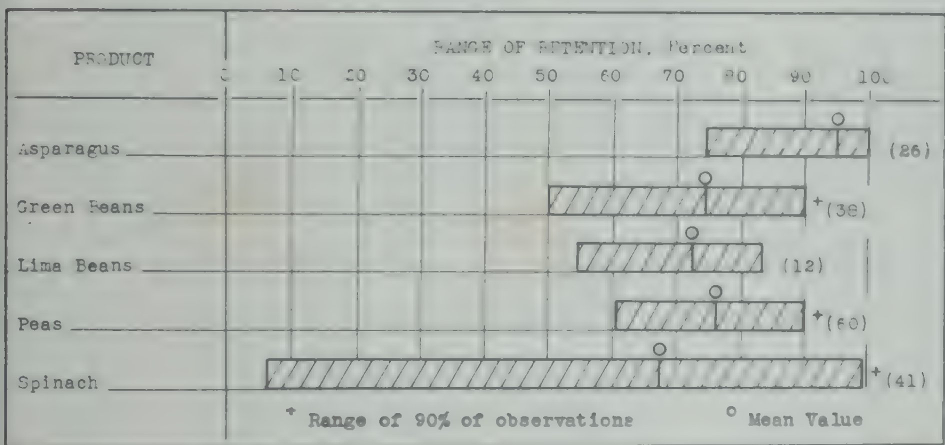

Fig. 8. Ascorbic acid retentions during blanching.

as possible. Figure 12 (page 13) showing the ascorbic acid retention in canned orange juice at different temperatures(27) (28), clearly emphasizes this point. The canned food nutrition program sponsored several projects on the effect of sustained constant temperatures on the vitamin content of canned foods. These projects were supplemented by a survey of temperatures existing in canned food warehouses in the United States, and by vitamin analyses of canned foods stored under known warehouse temperature storage conditions. The results of the latter surveys (5) are summarized in table XI, (page 12) . Summaries of the effects of sustained 50°, 65°, and 80°F storage, on vitamin retentions for one year and two year periods for a number of products are well summarized in the National Canners Association publication previously mentioned.

In the United States the medical profession is giving a great deal of attention to the nutritional aspects of low sodium diets for the treatment of a number of disease conditions such as hypertension, congestive heart disease, and certain kidney disorders. As stated in Dr. F.C. BING's recent report (29), the unrestricted American diet contains about 4 to 8 grams of sodium per days. The elimination of a few salted foods and the use of no salt in the kitchen or at the table will reduce this intake from 1.5 to 3.0 grams daily. This represents the level of sodium in a mildly restricted diet. Moderate restriction of sodium to a level of 0.5 to 1.5 grams daily requires the elimination from the diet of many processed foods which are flavored with salt, such as canned vegetables and a selection of foods which are not naturally high in sodium content. A severely restricted low sodium diet provides less than 0.5 gram of sodium daily and requires very rigid supervision.

Because of the increasing demand for foods for low sodium diets, the canning

TABLE IX. THIAMINE RETENTION DURING HEAT PROCESSING (Per Cent)

Canned Foods	Can size	Clifcorn and Heberlein	Wagner et al.	Guerrant et al.	Lamb et al.
Asparagus, green	No. 2	...	69-89	...	64-77
Asparagus, green	No. 300	63-66	...	...	...
Asparagus, white	No. 2	...	...	...	72-85
Beans, green	No. 2	73-79	69-91	70	60-88
Beans, green	No. 10	...	92	67	61-92
Beans, Lima	No. 2	58-71	50-87	60	...
Beans, wax	No. 2	...	...	67	...
Carrots	No. 10	...	...	100	...
Corn, whole grain	No. 2	...	35-38	25	33-53
Corn, whole grain	307 x 306	...	...	25-50	...
Peas	No. 2	59-69	59-77	56	50-83
Peas	No. 10	...	57-84	...	46-66
Spinach	No. 10	...	...	33	...
Tomatoes	No. 2	89	...	...	...
Tomatoes	No. 10	...	...	100	...
Tomato juice	No. 2	74	...	82	88-100
Tomato juice	404 x 700	...	...	83-100	95-100

industry concluded that it could contribute to the fiels of dietary therapy by making available processed foods which are palatable and economical and which are of known sodium content by label declaration. It is said by many that the potential market for low sodium foods in the United States may equal the market for canned strained and chopped foods for infants and small children. Many canned fruits and fruit juices are sufficiently low in sodium to be useful even in the most restricted diets. Because of the salt added to most canned vegetables, they are not suited for such use. When they are water packed, however, they have a sodium content approximating that of the fresh vegetables. To be most useful to the doctor, the dietician, and the patient, the sodium on the label in milligrams of sodium per 100 grams of product.

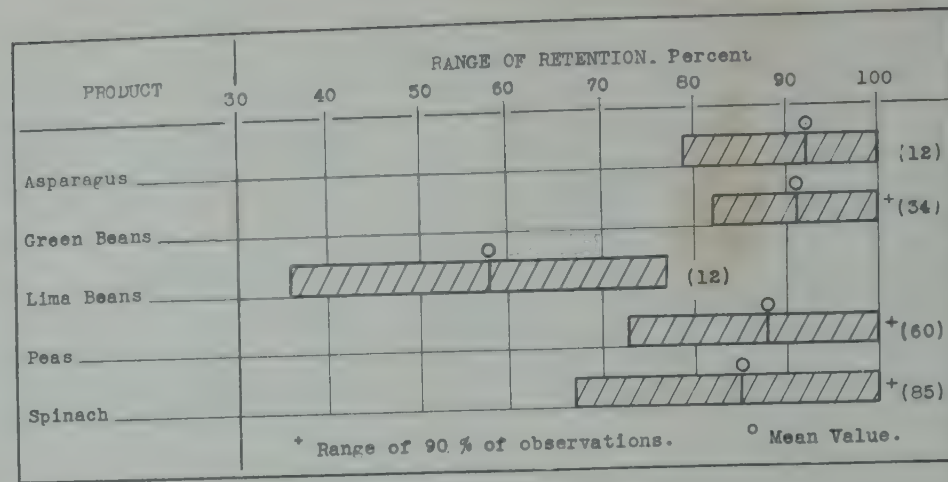

Fig. 9. Thiamine retentions during blanching.

TABLE X. A COMPARISON OF THE EFFECTS OF END-OVER-END TYPE OF AGITATION (R-4) WITH CONVENTIONAL STILL PROCESSES ON THE LENGTH OF PROCESS REQUIRED FOR VARIOUS CANNED FOODS

Product	Can Size	Process			
		Agitated		Conventional	
		Time Min.	Temp. °F	Time Min.	Temp. °F
Peas	307 x 409	4.9	260	35	240
Carrots	307 x 409	3.4	260	30	240
Beets-sliced	307 x 409	4.1	260	30	240
Asparagus-spears, cuts and tips	307 x 409 307 x 409	4.5 4.0	270 270	16 15	248 248
Cabbage	307 x 409	2.75	270	40	240
Asparagus-spears :					
brine packed	307 x 409	5.2	260	50	240
brine packed	603 x 700	10.0	260	80	240
vacuum packed	307 x 306	5.0	260	35	250
Mushroom soup	603 x 700	19.0	260	..	..
Evaporated milk	300 x 314	2.25	260	18	240

TABLE XI. VITAMIN RETENTIONS IN CANNED FOODS DURING WAREHOUSE STORAGE.
(12 Months' Storage Time)

Locality	Storage Temp. Yearly		Per Cent Vitamin Retention						
			Ascorbic acid			Thiamine			Carotene
	Average	Range	Orange juice	Tomatoes	Peas	Orange juice	Tomatoes	Peas	Peas
	(°F)	(°F)							
Arizona	72	50-92	81	100	92	99	89	89	100
California, Central	66	51-87	92	102	94	96	86	92	100
California, North	70	54-104	86	105	94	99	88	85	97
District of Columbia	63	42-79	91	101	96	103	90	90	98
Florida	77	54-91	81	92	96	95	79	85	97
Illinois	59	28-92	90	98	96	99	89	89	98
Louisiana	77	50-98	73	83	92	96	83	83	97
Missouri	61	36-87	91	101	98	95	89	96	98
New-York	58	30-78	96	106	93	98	96	91	97

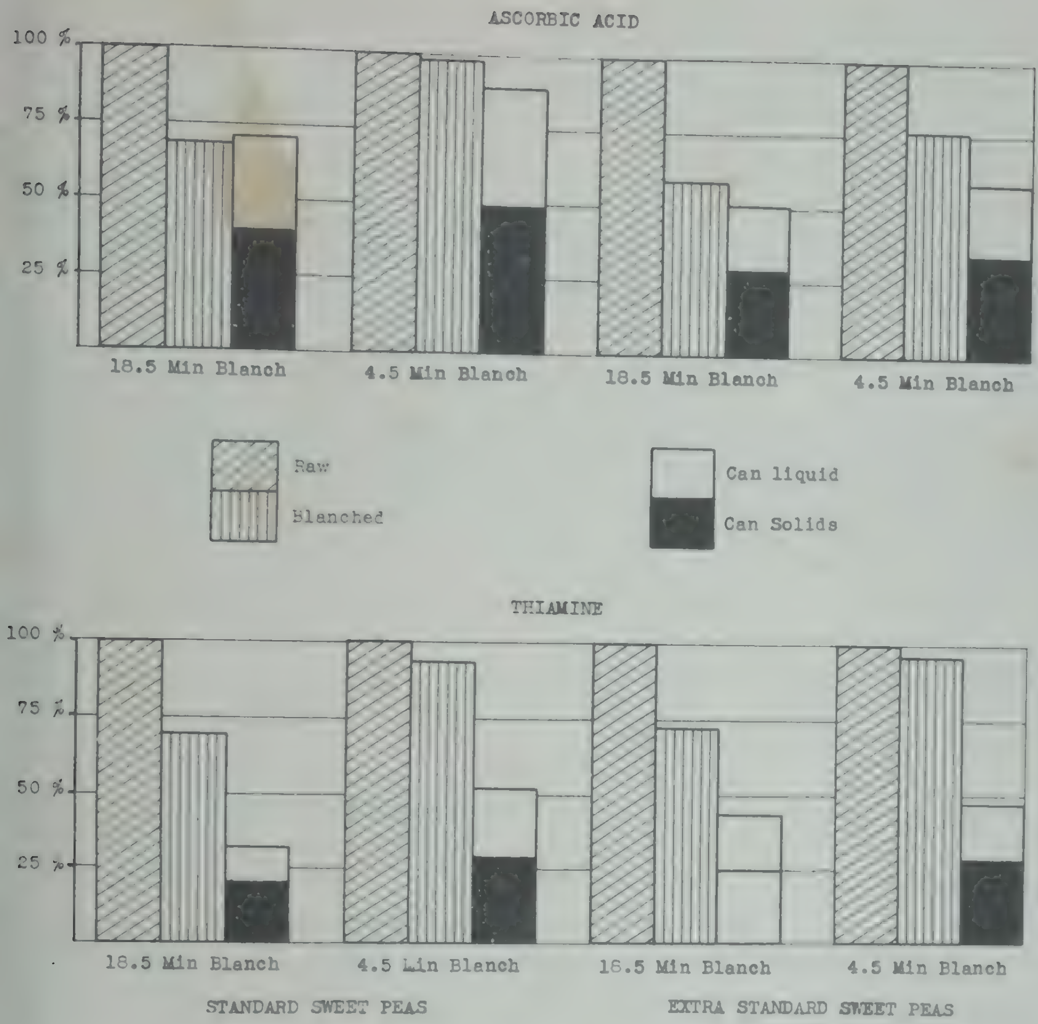

Fig. 10. Influence of blanching time on retention of vitamins.

The canned food nutrition program has been enthusiastically obtaining analytical data on salt- and sugar-free packs of canned fruits and vegetables. The omission of sugar is for the specific purpose of rendering the product of greater use in low calorie diets. By the analysis of such dietetic canned foods for sodium and proximate composition, an abundance of helpful information has been obtained.

At the last National Canners Association meeting, Dr. J. R. ESTY (30) summarized the results obtained to date on the sodium content of salt-free dietetic packs as follows :

"...our present knowledge of the " sodium content of canned fruits " and vegetables packed in water, with " no salt or other sodium compound " being added or coming in contact " with the food so as to be carried " over into final product, the following products were found to have a " sodium content below 10 milligrams " (mg) per 100 grams (g), and with a " few exceptions these products had " a sodium content of below 5 mg per " 100 g.

" Applesauce; apricot halves, " unpeeled; asparagus, green; asparagus, green, tipped and white; beans, " green ; boysenberries; cherries; " corn; fruit cocktail; grapefruit, " segments and juice; grapes, Thompson " seedless; lemon juice; orange juice; " peaches, clingstone, halves or " slices; peaches, freestone, halves " or slices; pears; pineapple, slices " or juice; and plums, purple.

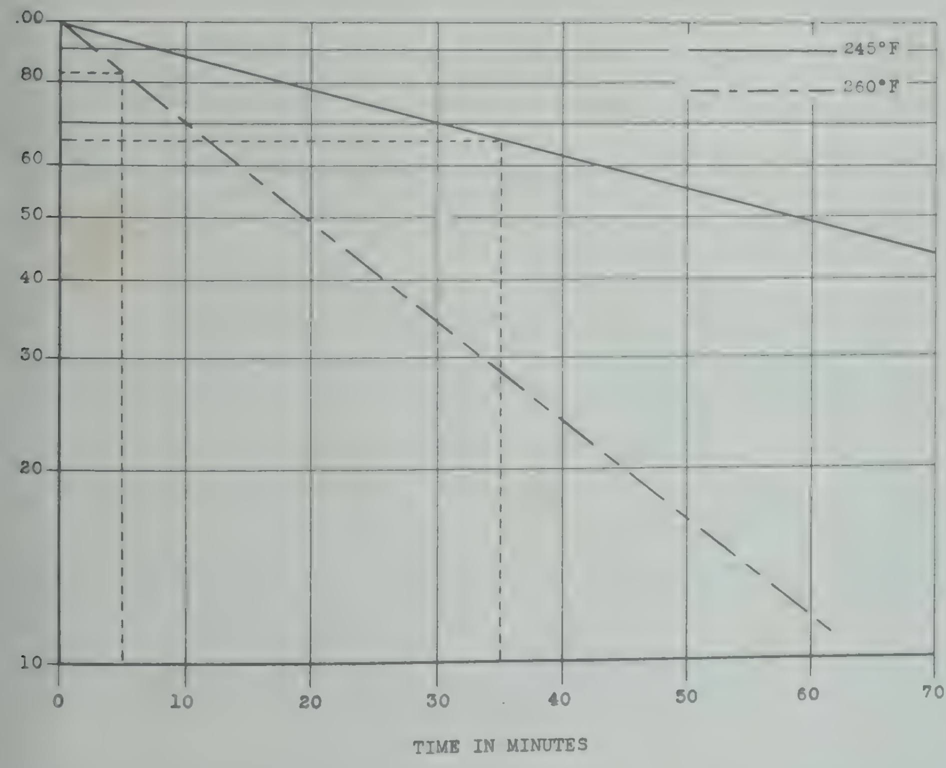

Fig. 11. The comparative rates of thiamine retention in peas as affected by processing time and temperature.

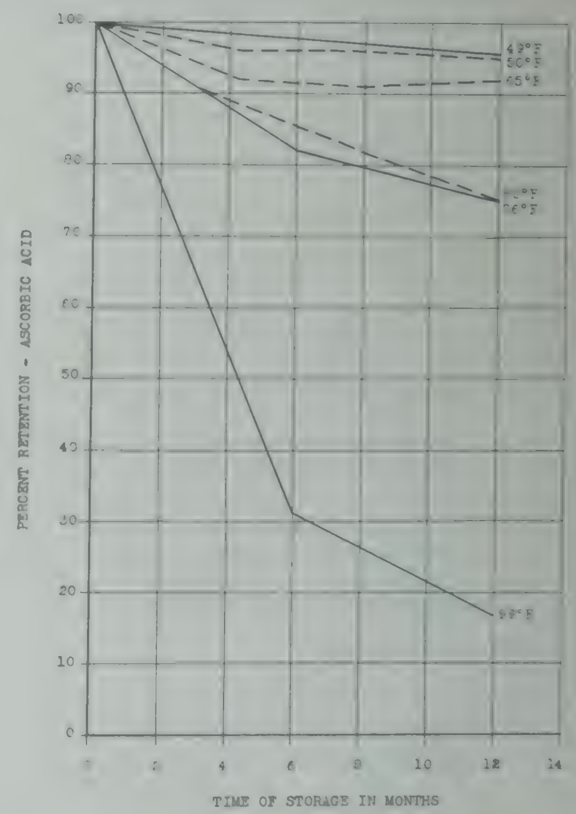

Fig. 12. Ascorbic acid retention in canned orange juice at different storage temperatures (- - Moschette et al., —— Ross).

" In the case of figs, the sodium content of the samples tested varied from 6 to 20 mg per 100 g. To-
" matoes and tomato juice were found to contain up to 35 mg of sodium per 100 g. The variation in these
" products was very great and the data are insufficient to draw conclusions. The sodium content of Lima
" beans ranged from 5 to about 40 mg per 100 g, and that of peas varied from 4 to over 50 mg per 100 grams.
" Spinach was found to average about 50 mg of sodium per 100 g and no results were reported exceeding 100 mg.
" The same applies to beets and carrots ".

It was shown that operations such as lye peeling, the treatment of products such as pears with salt spray to prevent discoloration, the salt brine quality grading of peas and Lima beans, and the use of Permutit (zeolite) softened waters in the canning operations must be avoided to prevent excessive pick-up of sodium in the final canned product. Further work is being conducted this year involving sodium determinations on ten new products. The proximate analyses are being simultaneously conducted on all products to provide information for use mainly in the proper planning of low-calorie or low-carbohydrate diets.

In conclusion to this discussion, it should be realized that is has been necessary, because of time limitations and the wide scope of the subject, to pass over many phases of the work very rapidly. Typical findings have been presented to give you a broad picture of the entire effort in this field of research. If more information is desired, it may be obtained from the references which have been cited, or from any one of the individuals who have been associated with this canned foods nutrition program. We know that the food patterns are different in Europe as compared with the United States. Nevertheless, the information which has been discussed can be beneficial to all if it is used. The big job now is one of education. It is claimed that more is known about the nutritive value of commercially canned foods than is known about any other class of food products. In behalf of all who have contributed to this knowledge, it is my privilege to say, " We are happy to make this information available to you ".

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III. ON THE COMPARATIVE DIGESTIBILITY OF CERTAIN FOODS, FRESH AND CANNED

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MELNICK, OSER and WEISS (1) were the first to draw attention to the importance of the rate of liberation of amino acids by enzymes in the body's utilisation of food proteins. According to these authors, the low nutritive value of raw soya protein can be attributed to the slow liberation of certain amino acids, particularly methionine. Recently, Ernest GEIGER (2) has put forward some original work which proves the importance of simultaneously bringing together in the tissues the various amino acids in order that proteins can be built up. He discusses various experiments concerning the role of the rate of enzymic breakdown of proteins in their absorption by the intestin and the resynthesis of proteins specific to the body (3). It would, therefore, appear to be quite justifiable to compare the rates of digestion of protein in fresh and canned foods.

The first stage in the research consisted in studying the enzymic hydrolysis by trypsin in vitro of protein by a technique inspired directly by the work of Daniel MELNICK and Bernard L. OSER (4). The food, cooked by canning or by household methods, the exact details of which were recorded in each case was ground in a vegetable mill so as to obtain a puree as smooth and homogenous as possible. The approximate protein content was calculated from a nitrogen estimation and from this was determined the weight of a sample equivalent to about 3 g of protein. A first sample was suspended in 60 c.c. of buffer solution pH 8.4 (250 c.c. of a solution of M/5 $KH_2 PO_4$ plus 240 c.c. of M/5 NaOH. Dist. water ad 1000 c.c.).

After carefully homogenising the suspension the pH was again measured and adjusted to 8.4 with a solution of N/10 soda, then was added 100 mg of pancreatine (150 Codex) suspended in 10 c.c. of pH 8.4 buffer, 25 c.c. dist. water and with 5 c.c. of toluene as an antiseptic. The flask was then incubated in a thermostat at 37°C, zero time being carefully noted. Samples were removed at time - T_1, T_2 and T_3; formol titrations were then carried out by means of a Coleman protentiometer, and the values found were expressed by the letters A_1, A_2, and A_3. Another sample of the identical material was taken and submitted to the same treatment except that the pancreatine was inactivated by heat (in a boiling water bath for five minutes). This sample was put in the thermostat for 24 hours, and a formol titration gave the value B for the initial hydrolysis. Finally another sample identical to the proceeding ones to which had been added 75 c.c. of 8N sulphuric acid was boiled under reflux for 33 hours; 80 c.c. of a buffer solution pH 8.4 was then added and the value obtained from a formol titration (C) represents the maximum hydrolysis of the proteins into amino acids.

The percentage hydrolysis in a given time was calculated as follows :

$$h = \frac{A - B}{C - B} \times 100$$

<u>NOTA</u> : Figures between ( ) refer to Bibliography, p. III - 5.

Results obtained

We studied by means of this technique the meat of pigs, cows, tunny and sardine, and for vegetable foods, peas and beans. For each of these foods, the fresh or canned materials were obtained either from the same sample of seed or from a given tissue of any animal.

I. BUTCHERS MEAT

1. Beef

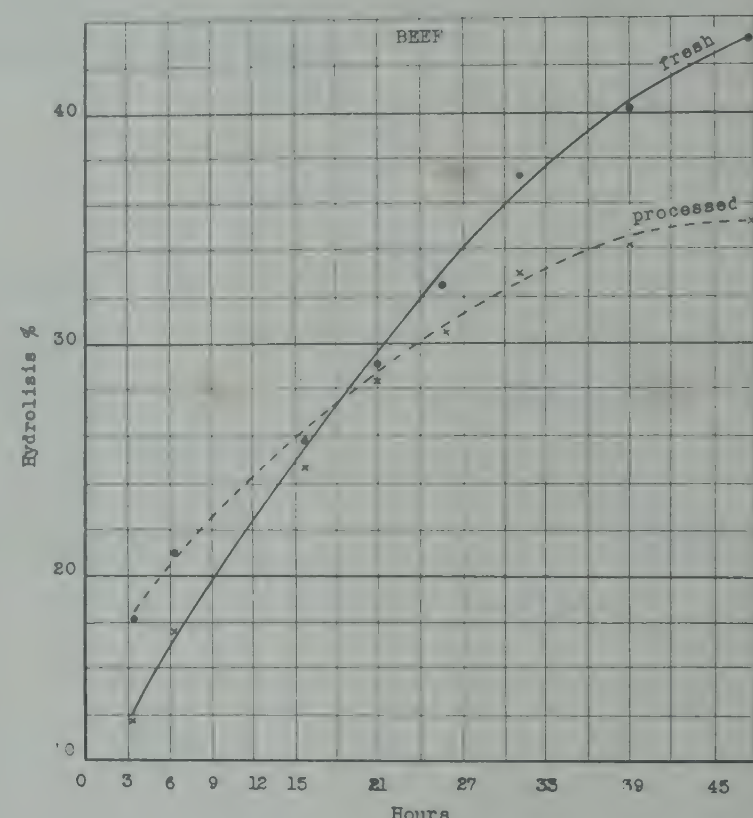
The fresh material (domestically cooked) was held for one hour in boiling water to which had been added 15 grams of salt per litre. The broth was then concentrated and added to the chopped meat. The canned meat was prepared as follows :

Pieces of about 500 grams were cooked for 55 minutes in boiling water with 15 grams of salt per litre. The pieces of meat taken from the broth were then cut up into smaller pieces and put into the can. The concentrated broth was then added to the cans while boiling, and after closing they were sterilized at 118°C for 90 minutes.

The following results were obtained :

Per cent hydrolysis in a given time.

Time in hours	Canned Meat	Domestically cooked Meat
3 1/2	18.3	13.8
6 1/2	21	17
16	25.7	24.9
21	28.1	28.8
25 1/2	30.5	32.5
31	32.8	37
40	34.2	40.3
48	35.2	43.2



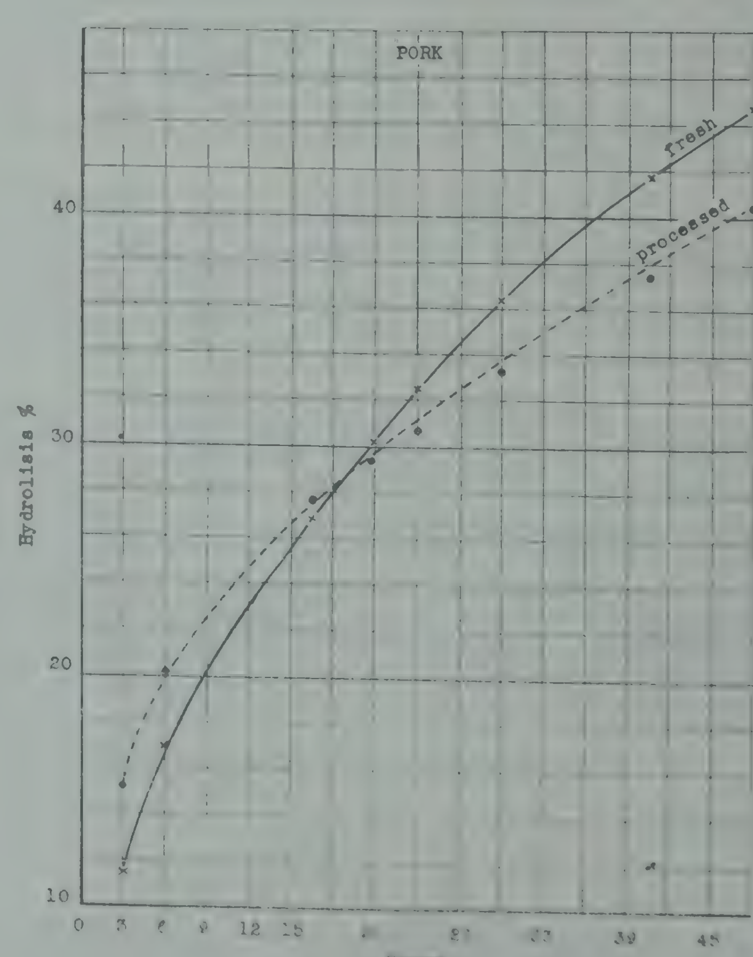
It will be seen from this that during the first sixteen hours the canned meat is digested more rapidly than the domestically cooked meat. The contrary is observed from the 20th to the 48th hour.

2. Pork

The method of preparation is the same as that used for beef, both for the domestically cooked and for the canned meat.

The percentage hydrolysis in a given time was as follows :

Time in hours	Canned Meat	Domestically cooked Meat
3	15.4	11.7
6	20.3	16.8
16 3/4	27.8	26.6
20 3/4	29.6	30.2
24	30.9	32.5
30	33.2	36.4
41	37.2	41.9
48	40.2	44.7



As for the beef, the digestion of the canned meat is more rapid during the first 16 hours, then about the 20th hour the effect is reversed.

II. FISH

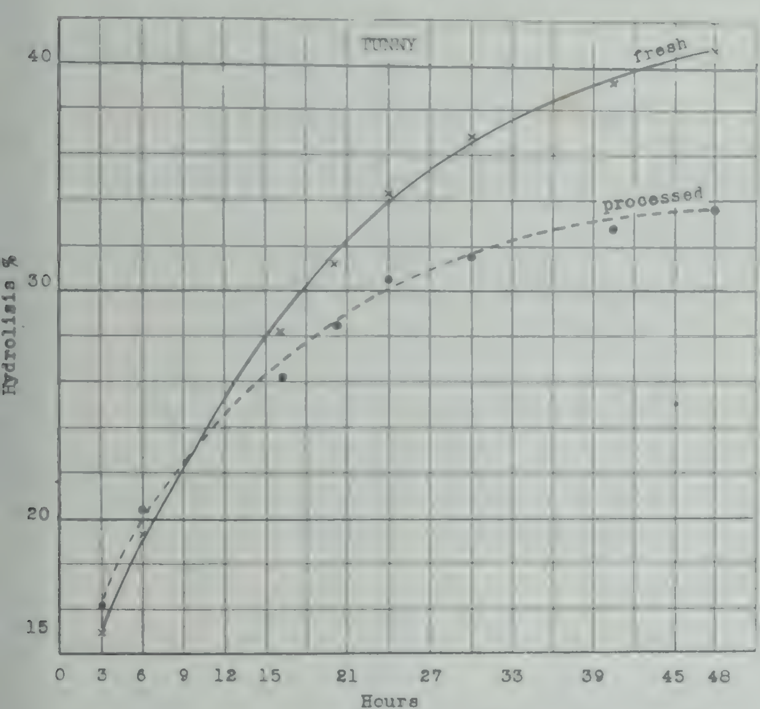
1. Tunny

The fresh tunny was washed in running water then cooked for an hour in boiling five per cent brine. The drained fish was then skinned, boned and finally milled. The canned tunny was prepared "au naturel" in the following way. After two and a half hours immersion in a 20 per cent brine, it was washed in fresh water and trimmed. Slices of raw fish were then put into the can, a five per cent brine added, and the cans were then exhausted. They were closed at 85°C approximately and sterilised for two hours at 115° and 116°C.

The following results were obtained :

Percentage hydrolysis in a given time.

Time in hours	Canned Tunny	Tunny cooked domestically
3	16	15.2
6	20.4	19.6
16	26	28
20	28.4	31.2
24	30.4	34.4
30	31.6	36.[illegible]
40	32.8	[illegible]
48	33.6	[illegible]



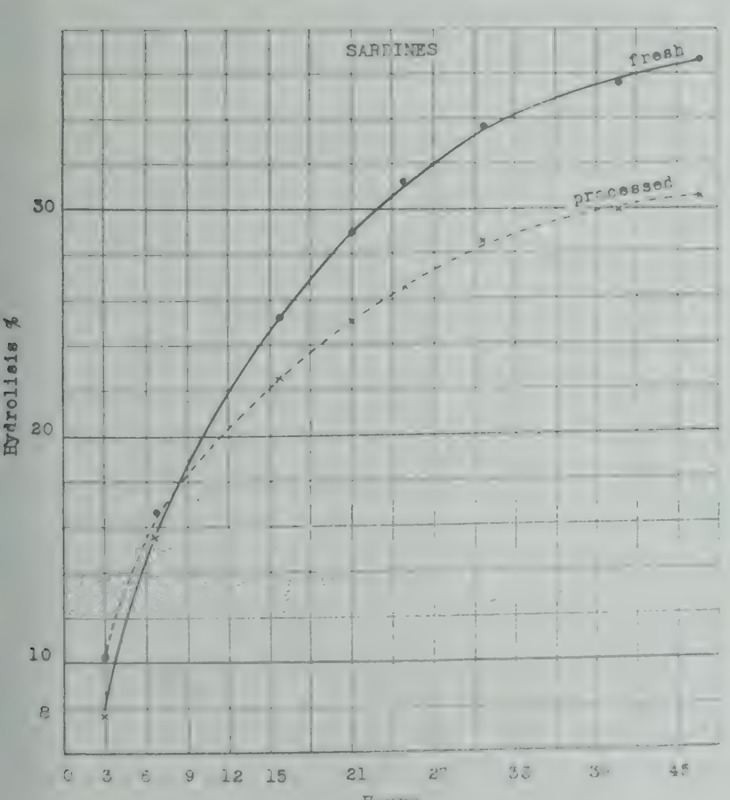
As for beef and pork, the digestion of the canned tunny is more rapid at the beginning, but this only lasts for about seven hours after which the canned tunny is digested more slowly.

2. Sardines

The fresh sardines after beheading and evisceration, were washed in cold water and drained. They were then held for five or ten minutes in a 2 per cent brine at a temperature of about 95°C, until completely cooked. Finally they were milled after draining. Sardines for canning, after beheading and evisceration, exactly as before were immersed in saturated brine (25° B) for 25 minutes, and then after rinsing and draining they were cooked for two and a half minutes in a two per cent brine at 90 to 95°C. After draining and cooling the sardines were put into the cans and boiling two per cent brine added. The cans were closed at [illegible]°C, sterilised at 115°C for 110 minutes.

The following results were obtained :

Percentage hydrolysis in a given time.



Time in hours	Canned Sardines	Sardines cooked domestically
3	10.1	7.9
7	16.9	15.8
16	22.4	25
21	24.8	28.7
25 1/2	26.4	31.2
31	28.4	33.7
41	29.9	35.4
47	30.3	36.2

The results are near enough to those obtained

for tunny. For rather more than seven hours, the digestion of the canned fish is more rapid than that domestically cooked, it then becomes slower.

III. VEGETABLE FOODS

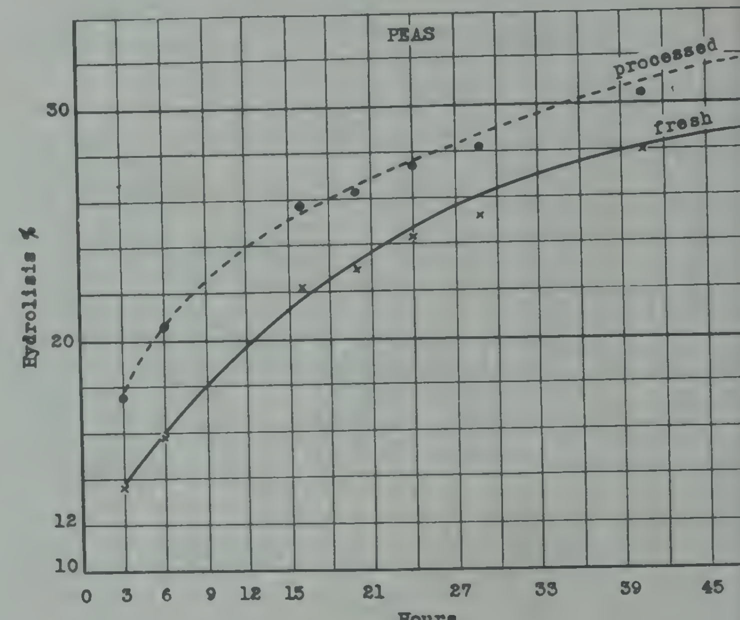
1. Peas

The peas used were grade "fins". For domestic cooking, they were washed in fresh water, and then cooked in boiling two per cent brine; after draining, the peas were milled. The first treatment to which the canned peas were subjected was a five minutes blanch in boiling water. This was followed by rinsing in fresh water, then they were drained and put into the can. Boiling two per cent brine was then added, and the cans were exhausted to a temperature of 90°C at their centre, closed and sterilised for 40 minutes at 115 to 116°C.

The following results were obtained :

Percentage hydrolysis in a given time.

Time in hours	Canned Peas	Peas cooked domestically
3	17.7	13.8
6	20.6	15.8
16	25.7	22.2
20	26.3	22.9
24	27.1	24.2
29	28.1	25.1
40 3/4	30.3	28
48	31.6	28.9



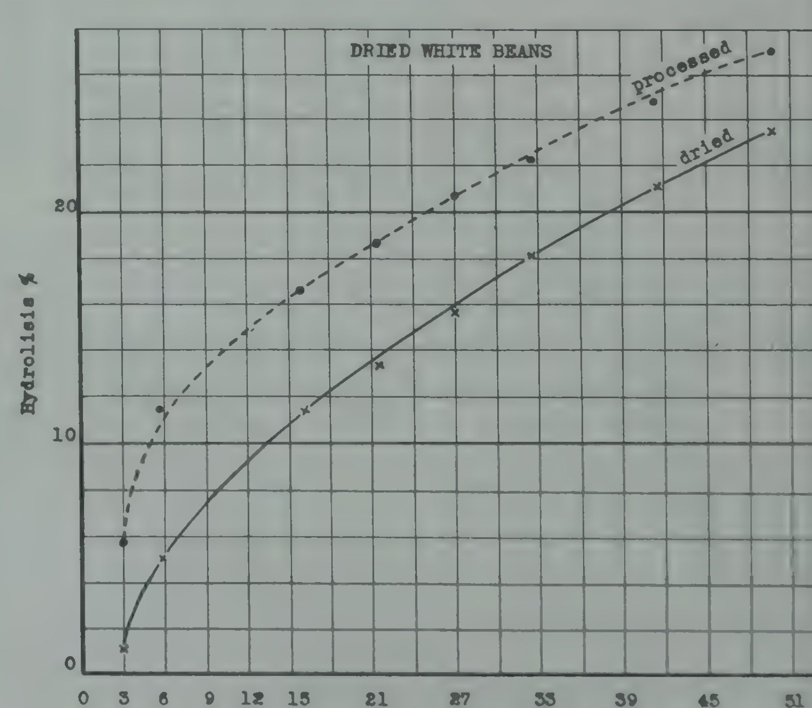
For peas during the whole of the experiment the rate of digestion of the canned products was more rapid than that of the domestically cooked vegetables. The two curves are approximately parallel.

2. Beans

The beans used were dry white beans, those domestically cooked were washed and then soaked over night. After draining, they were cooked in boiling water (50 per cent tap water and 50 per cent distilled water) to which 1.5 per cent salt had been added. After draining they were milled. The beans for canning were washed, and then soaked for twelve hours, then after draining they were blanched for twenty minutes in boiling water with 1.5 % salt. After cooling they were put in the cans and boiling 1.5 % brine (50 per cent tap water and 50 per cent distilled water) was added. The cans were exhausted, closed at 85°C and finally sterilised for 85 minutes at 115°C. The results were as follows :

Percentage hydrolysis in a given time.

Time in hours	Canned Beans	Beans cooked domestically
3	5.8	1.2
5 1/2	11.05	4.9
16 1/4	16.7	11.2
21 1/2	18.8	13.5
27	20.7	15.8
32	22.4	18
41 1/2	24.8	21.2
49 1/2	27	23.6



The results obtained were exactly the same as for peas, the digestion of the canned peas being more rapid than that of the domestically cooked ones during the whole time of the experiment.

SUMMARY

For the foodstuffs considered the tryptic digestion of canned foods is more rapid than that of domestically cooked ones, at least during the first seven hours. This difference is very small for canned fish, but more marked and more prolonged (16 hours) for canned meats and much more important for canned vegetables. It is possible that the difference could be particularly due in this latter case to the action of the canning process on the cellulose membranes. It would appear that from the point of view of a physiological interpretation of the facts, that it is the first hours of digestion which are most important. However an in vitro study such as we have carried out, departs more and more from natural conditions, and loses more and more of its value the longer it is continued, particularly because of the accumulation of the products of hydrolysis which in the body are removed from the place where the digestion is carried out.

In conclusion, it appears that the canning of the above foods in the conditions described, results in a more or less substantial increase in the speed of digestion of the protein constituents.

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IV. TWELVE YEARS PROGRESS IN THE CANNING OF FISHERY PRODUCTS

by M. JUL, Chief of the Technology Branch,
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This survey covers the development of the canning of fishery products since the time of the First International Congress of Canned Foods in Paris in 1937. These twelve years have been a period of rapid progress for the industry. Canning of fishery products was taken up in many areas where there previously was little or no such activity; new products have appeared and many new methods and machines have come into use. On the whole, this represents such a variety of new developments that it is not possible to describe them all in the present study. It is hoped, however, it will be at least fairly representative of the industry's progress.

Most of the information used is based on special papers describing the progress of the canning industries in the various countries. These papers were prepared for the Second International Congress of Canned Foods in Paris, 16-19 October 1951, by the following countries: Algeria, Australia, Belgium, Denmark, France, Israel, Morocco, Portugal, Sweden, Tunisia, United Kingdom, Union of South Africa and the United States. Further information has been collected from scientific and trade publications and from many personal communications which the author has received.

I. PRODUCTION

Not all countries have statistics which indicate their production of canned fishery products. Even for countries where such statistics exist, they are not always comparable. Some countries, for instance, indicate the net weight of the fish canned, others the total weight including brine, cans, cases, etc.. Some statistics do not distinguish clearly between canned and otherwise preserved fishery products. Nevertheless, tables I to IV (pp.2,3 and 4) prepared by the Economics Branch of the Fisheries Division of FAO, do show that in the countries where production conditions are normal, remarkable progress has taken place in the volume produced over the last 12 years.

The development in the following countries is of particular interest. The Union of South Africa produced 100 to 150 tons of canned pilchard, while the production in 1950 was well over 10,000 tons.

Similar developments have taken place in other parts of Africa, notably Morocco which has 48 fish canning plants in 1938 and nearly 200 in 1950. The fish canning activities were increased particularly in the southern part of the country; for instance, the town of Agadir has no fish cannery at all in 1938, but has 54 in 1950.

Similarly, in 1938 Algeria had 22 fish canneries, most of which of rather primitive design, without steam installations; in 1951, it had 48 canneries with much improved equipment, all using steam processing.

The production of canned fish in Tunisia has increased so much that the country which in 1938 imported 1,000 tons of such products was able to export 3,000 tons in 1950.

Development has also been amazing in Australia where the pack in 1950 was 18 times as high as the pack in 1938. Spectacular progress took place in Peru, where a very modern tuna or bonito canning industry was established during World War II. Production rose from virtually nothing to about 9,000 tons in 1950 and the production has been growing steadily. Many well equipped canning plants were built and the industry found a ready market for its products, mainly in the United States. Fish canning activities have also been considerably increased in Chile, but the development has not been the same as in Peru. This has probably been due mainly to the fact that Chile has not found as well established marketing channels for its products as those that were established by Peru.

A remarkable development has also been that of the industries in Denmark and the Netherlands, the production in these countries increasing very significantly from 1938 to 1950. Here the industry could not be based on any heretofore unused fisheries resources. Only a verly close survey of the marketing situation made it possible to find new products for which a ready market could be found.

TABLE I

TOTAL CANNED FISHERY PRODUCTS AS PRODUCED BY SPECIFIED COUNTRIES, 1938 and 1946-50.

Country	1938	1946	1947	1948	1949	1950
	Metric tons (1)					
Australia (2)	(3) 273	471	1 686	5 547	4 938	(4) 3 157
Belgium	(5) 1 401	3 067	2 693	1 029	1 100	682
Canada ....(6)	47 850	77 870	91 823	54 234	43 224	45 576
Newfoundland	(5) 144	490	470	547	377	196
Chile	...	2 750	2 184	2 318	4 558	(7) 4 500
Denmark ...(8)	2 350	1 690	3 935	7 100	7 900	7 850
Finland	(5) 30	400	450	500	400	400
France ....(9)	(7) 12 838	12 850	20 600	32 360	35 050	35 900
French Morocco (5)	13 839	(5) 6 596	(5) 10 241	(5) 28 004	35 000	45 520
Germany ...(10) (11)	28 151	583	1 643	7 900	16 200	17 000+
Iceland ...(5)	78	530	161	200	130	56
Ireland	-	-	70	404	298	18
Italy	7 700	9 300	12 250	8 500	5 759	6 300
Japan .....(5)	100 969	(12) 1 825	2 250	4 167	6 136	38 737
Netherlands...(5)	554	4 090	6 870	6 195	6 900	5 575
Norway ....(7)	35 970	25 310	36 110	50 120	42 470	33 390
Peru ......(5)	...	2 652	4 618	4 872	6 199	8 721
Portugal ..(5)	34 461	29 790	37 536	19 812	15 728	31 358
Spain	...	49 956	35 457	32 957	48 836	61 775
Sweden	1 430	1 730	2 070	2 050	2 000+	2 000+
Tunisia ...(5)	202	1 207	969	2 480	3 492	3 041
Union of South Africa and South West Africa (13) ...	-	8 830	9 125	12 473	14 026	15 000+
United Kingdom.....(14) ...	3 005	5 080	6 990	10 571	14 380	11 726
United States of America (15).	302 791	317 230	342 067	354 802	387 826	424 100
Venezuela	...	7 789	7 477	9 273	7 700	7 000+
Total	...	572 086	639 745	658 415	710 627	809 578

Source : Official publications and communications.

Note : In addition to the above, the following figures are available : Algeria (1938) 3,500+ and (1950) 8,000; Brazil (1946) 591; Egypt (1946) 10; and Mexico (1946) 13,500. No other figures are readily available.

\+ FAO estimate.

(1) Product weight, unless otherwise indicated.
(2) Edible weight; excludes crustaceans and mollusks and fish paste.
(3) 1939.
(4) Subjected to revision.
(5) Exports.
(6) Excludes Newfoundland.
(7) Herring and similar species and tunas, true mackerels and similar species only.
(8) Excludes Faeroe Islands and Greenland.
(9) Metropolitan France only, except 1938.
(10) Federal Republic of Western Germany, 1946-1950.
(11) Herring and similar species only.
(12) Salmon and similar species, herring and similar species, tunas, true mackerels and similar species only.
(13) Fiscal year, 1 November to 31 October.
(14) Excludes Northern Ireland and (in 1949 and 1950) Isle of Man.
(15) Includes Alaska.

TABLE II

PRODUCTION OF CANNED HERRING AND SIMILAR SPECIES IN SPECIFIED COUNTRIES

Country		1938	1946	1947	1948	1949	1950
		Metric tons (1)					
Belgium		560	3 036	2 643	979	1 046	682
Canada		6 958	38 980	44 569	19 873	8 199	9 067
Newfoundland		-	54	45	303	222	26
Chile		...	500+	568	671	1 864	2 000+
Denmark .....(2)		920	565	800	2 400	2 800	3 500
Finland		...	400	450	500	400	400
France ......(3)	(4)	1 938	5 300	13 500	12 980	16 750	17 200
French Morocco	(4)	12 779	10 000+	15 000+	20 000+	35 000	41 880
Germany		28 151	583	1 643	7 900	16 200	17 000+
Ireland		...	100+	70	393	267	-
Italy		6 000	5 000	5 500	5 500	4 427	5 000
Japan	(4)	28 170	650	563	817	4 060	12 445
Netherlands		...	2 800	4 000	4 500	5 000	4 000
Norway		35 400	24 900	34 600	41 100	35 000	23 800
Portugal	(4)	30 477	27 793	37 536	18 199	13 372	29 259
Spain		...	10 000+	10 000+	9 000+	10 000+	10 000+
Union of South Africa and South West Africa (5)		-	3 420	3 454	5 319	7 488	10 000+
United Kingdom	(6)	3 005	5 020	6 990	10 571	14 380	11 726
United States of America	(7)	59 130	98 312	68 541	93 932	145 200	181 800
Venezuela		...	7 789	7 477	9 273	7 700+	7 000+
Total		...	245 262	257 949	264 210	329 375	386 785

Source : Official communications.

+ FAO estimate

(1) Product weight, unless otherwise indicated.
(2) Excludes Faeroe Islands and Greenland.
(3) Metropolitan France only, except 1939.
(4) Exports.
(5) Fiscal year, 1 November to 31 October.
(6) Excludes Northern Ireland and (in 1949 and 1950) Isle of Man.
(7) Includes Alaska.

Tables I and II show another interesting fact. Canning of herring in Canada and the canning of sardines in Venezuela was very considerable during the war years and in the period of food scarcity immediately following the war. Now, the production has decreased very markedly. This is not due to any disappearance of the fisheries resources nor has the catch been used for other products. The fishing activities have had to be curtailed simply because it was not possible to find a profitable market for the canned product. This means that in effect large food resources are left unused, in spite of the fact that there are fishermen who could fish them, canneries which could process them and that the world has a very large food deficiency with many population groups being undernourished or even starving. This should be a challenge to fish canners and food technologists. It is not easy to make canned products from herring and herring-like fishes which are attractive to population groups, which are not accustomed to such food, and still cheap enough to be within the reach of their income. Nevertheless, it is likely that much could be done in this field. The problem is certainly of such importance that it merits close study.

TABLE III

PRODUCTION OF CANNED SALMON IN SPECIFIED COUNTRIES

Country		1938	1946	1947	1948	1949	1950
		Metric tons (1)					
Canada		37 206	29 404	33 300	28 511	31 264	32 300
Newfoundland	(2)	18	29	22	125	87	85
Denmark ..... (3)		-	40	40	30	50	50
Japan		...	300	188	24	165	379
United States of America (4)		158 632	100 808	123 045	105 219	120 300	91 400
Total		...	130 581	156 595	133 909	151 866	124 214

Source : Official communications.

(1) Product weight, unless otherwise indicated.
(2) Exports.
(3) Excludes Faeroe Islands and Greenland.
(4) Includes Alaska.

TABLE IV

PRODUCTION OF CANNED TUNAS, TRUE MACKERELS AND SIMILAR SPECIES IN SPECIFIED COUNTRIES

Country	1938	1946	1947	1948	1949	1950
	Metric tons (1)					
Canada	14	2 100	1 707	1 312	660	293
Chile	...	700+	1 249	1 513	2 442	2 500+
Denmark .....(2)	525	480	1 070	1 500	3 000	2 300
France ......(3)	10 900	7 550	7 100	10 980	14 900	17 500
Italy	...	4 300	6 750	3 000	1 332	1 300
Japan	...	875	488	313	749	20 739
Netherlands	...	125	350	160	700	700
Norway	470	410	1 510	620	290	1 660
Portugal	...	1 997	1 500+	1 527	2 211	1 698
United States of America (4)	(5) 51 006	(5) 62 264	74 834	(5) 89 530	74 800	90 300
Total	...	80 801	96 558	110 455	101 084	138 990

Source : Official communications.

Note : In addition, the following figure is available for French Morocco : 1950.. 1,820 tons. For Costa Rica in 1946, exports (which are indicative of production) amounted to 321 tons.

+ FAO estimate.

(1) Product weight.
(2) Excludes Faeroe Islands and Greenland.
(3) Metropolitan France only, except 1938.
(4) Includes Alaska.
(5) Includes jack mackerel.

II. FISHING

A canning industry is always completely dependent on the availability of suitable raw materials. The supply problem is probably especially important in the fisheries industries where most of the production of raw material is subject to uncontrollable natural factors which often result in large and unpredictable changes in the fish landings. Therefore, just as vegetable and fruit canners have to be concerned with problems of plant varieties and growing conditions, the fish canner has to keep in close touch with the development of fishing techniques.

These techniques have undergone very interesting developments since 1938. Fishing boats have been greatly improved. Especially noteworthy, so far as fishing for the canning industry is concerned, is probably the continuing development of the California tuna clipper which is now probably one of the world's highest developed types of fishing boats, with the cost of each unit often running well above US $ 500.000.

Of even greater importance for the industry has been the development of fishing equipment. Great advancement has been made by the increased use of echo sounders. It has proven possible to use echo sounders not only to find fish schools but also to determine their size, the direction of their movement and often even the type of fish in them (1). The development has been of such importance that in the Norwegian herring fishing fleet practically every boat is now equipped with an echo sounder, while the use of such equipment for fishing was practically unknown in 1938. The importance of this instrument is also indicated by the development in the California pilchard industry. Before the war, this fishery was carried out mainly in dark nights where the schools were spotted by the fluorescence they gave in the water. Fishing was practically stopped during periods of full moon. However, after echo sounders came into use, statistics show that fish catches have been practically independent of this factor.

The use of echo ranging equipment, normally termed Sonar or Asdic, for fish detection is still in the experimental stage. However, investigations carried out by the Norwegian research vessel " G.O. Sars " (2), show that it is possible by the aid of asdic to find and follow herring schools in mid-ocean in areas where the whereabouts of herring was practically unknown. The research vessel communicated its findings by radio telephone to units of the fishing fleet which thereafter obtained very good catches in areas where herring has never been caught before. The great importance of such developments are obvious; research in Norway is now concentrated on the development of a small combined asdic-echo sounder suitable for a fishing vessel.

Aeroplanes have also come into use for the spotting of fish schools. Many of the larger tuna boats operating out of California carry their own scouting plane (3). These planes can quickly cover a much larger area than the boat itself. From it, it is possible to spot a tuna school, mainly by the presence of porpoises, at a distance of 32-40 km (20-25 miles), while the range that can be covered from the crow's nest of a fishing boat hardly exceeds 3-5 km (2-3 miles). It was by such aerial spotting that the presence of larger schools of tuna was determined off the coast of Australia in surveys carried out immediately before World War II. Exploratory fishing carried out there in recent years with trolling and hook and line methods proved that good catches of tuna could be obtained; the country is now in the process of establishing a canning industry based on this resource.

It is often overlooked that the very wide use of radio telephone in itself has been a great aid for the fishing industries. This means make it possible for fishermen to communicate to one another knowledge

NOTA : Figures between ( ) refer to Bibliography, p. IV - 12.

of the presence of large fishing schools and also to advise in advance coastal operators, canners, etc.. of the size of their catch, the time it will be landed, etc....

The importance of developments in fish detection is well indicated by the fact that fishermen's associations in several countries, for instance Morocco and Sweden, operate special vessels equipped with all pertinent detection devices. These vessels, carry out scouting for fish for the main fleet and communicate their findings continuously by radio telephone.

Certain types of new fishing gear have also contributed to increased fish catches. For instance, the traditional drag nets or trawls, which are one of the most productive types of fishing gear, have the defect that they can only be operated close to the bottom of the sea. Many experiments were carried out with the purpose of designing a trawl capable of being dragged nearer the surface. This in theory is quite an easy problem but encounters a large number of practical obstacles. Finally the problem seems to have been solved a few years ago by a Danish inventor, LARSEN, whose so-called floating trawl (4) is now in general use by the fishermen in Northern Jutland. The use of the gear is credited with very large increases in herring catches. Needless to say that where such a gear is used, it is very important to follow the course of the fish schools with echo sounders in order that the net may be dragged at the right depth.

Of importance for the industry has also been the increased use of purse seines. This gear is now used very extensively in tuna fishing and has contributed to increased catches and more efficient operations. It has been tried for tuna fishing in Tunisia and Norway where it proved to be very efficient and where it is expected soon to be in extensive use.

Factory ships

There is within the industry a continuing interest in the use of ships which are completely equipped with processing equipment, for instance, canning equipment. While comparatively few such boats are in operation, it is always a very tempting thought that such factory ships can go right to the fishing grounds, process the catch while it is completely fresh and without the need for carrying any waste parts of the fish ashore.

However, when one considers the technical and economical problems involved, it is clear that the use of such boats is not easy to organise. For instance, a floating fish cannery factory must be completely equipped with all processing equipment, boilers, etc. and still must have hold space for storage of supplies, fresh water, finished products, etc.. In addition, it must carry quarters for the whole labor force for the canning plant. This labor force must be provided with food. The salary paid to such workers is generally considerably higher than that paid to shore workers and must be paid over the whole period of the trip, not, as in the case of shore operators, only while the plant is operating. Finally, great difficulties are experienced in the transfer of the catch from fishing boats at sea. If the factory itself is equipped for fishing, much greater fluctuations in the supply of raw material must be anticipated than what is normal for shore plants which generally can rely on the catch by a large number of fishing boats.

These considerations indicate that floating canning factories can only be operated economically successfully where no possibility for shore operations exist. It is known that both Russian and Japanese salmon and crab canning vessels have operated successfully in the northern Pacific Ocean. They may owe part of their success to the fact that the labor force used has very modest requirements as regards salary, food and living quarters. At present the possibility of the operation of floating crab canneries is being investigated by interests in the United States.

Thus, the operation of floating canneries is at the moment not extensive (5). However, the developments in the whale and the tuna industries deserve mention.

Several British and Norwegian whaling companies are at the moment trying to organise the canning of a part of the whale meat obtained in Antartic whaling operations. Some companies have provided canning facilities directly aboard the floating whale factories, while others have installed such equipment in auxiliary vessels. In this case , the problem is more of finding a product which will meet the requirements of the consumers who so far have been reluctant to accept whale meat in any form. Any development here is very important, especially because it is an attempt to use whale meat, a large part of which is otherwise discarded at sea and thus lost as a potential food supply.

Another interesting development, which is sometimes overlooked when factory ships are considered, is the fact that the California tuna clippers and some of the larger tuna purse seiners normally are equipped for freezing the catch aboard (6). The fish is chilled in cooled sea water; later on refrigerated brine is circulated over the fish until it is completely frozen; then the holds are emptied of brine and the fish kept in the frozen state by air refrigeration until it is landed. Some canners also operate carriers which freeze and transport the catch from the fishing fleet. These operations have been successfull because tuna is unusually well suited for canning even after it has been frozen, and because as a comparatively expensive fish it can easily carry the added cost of the freezing.

III. Raw Material

Important developments have taken place in the methods of supplying the canning factories with raw material. One new method is the use of pumps for unloading fishing boats, which is now in general use, for instance in the California pilchard industry and in the Maine sardine canning industry of the United States (7). These pumps are capable of unloading from 100 to 300 tons of small fish per hour and require only 2 workers for the whole operation. It is generally considered that unloading by pumps takes only 1/5 of the time and manpower required for usual unloading by brailing. Some unloading pumps are said to be able to handle fish as large as 91.cm (36 in.) in length. Therefore their use may be possible for fish other than herring and herring-like species.

Fish canners have always been faced with great fluctuations in the supplies of raw material. Many attempts have been made to even these out by preserving the fish by various means, especially by freezing.

This method presents, however, two difficulties.

Firstly, freezing is quite expensive and therefore difficult to apply for cheap fish such as herrings or pilchard. In addition, freezing does cause certain changes in the structure and flavour, which often make the canned product less attractive. As mentioned above, freezing of tuna before canning is used quite extensively. Raw material for the salmon canneries of Canada and the United States is also sometimes frozen, but it results in a somewhat less attractive canned product.

Experiments have been carried out quite extensively in Norway in using frozen sprats. It is said that it is now possible to use frozen sprats for canning but as far as is generally known, the method has not been used commercially.

Large experiments are being carried out in the United Kingdom, especially at the Torry Research Station in Aberdeen, aimed at the design of cheap freezing methods which would make it possible to preserve in bulk large supplies of herring for future processing. Various block freezing methods are being tested.

While so far freezing has proven to be difficult to adapt for this purpose, large improvements have been made possible by increased use of chilling and icing of the raw material. Extensive experiments were carried out in California, France, Mexico, and Norway. In Norway, for instance, it proved possible to extend the total keeping period of sprat from 4 to 6 days, from the water to the canning, by improved methods of icing.

In California and the Union of South Africa, use is made of refrigerating systems which circulate refrigerated brine over the pilchard in the storage bins, thereby increasing their keeping quality considerably.

IV. CANNING OPERATIONS

Fish canneries have profitted very substantially from progress made in canning techniques in general over the last years. They have particularly been subject to very considerable mechanization. It can, in fact, be said about the industry in many countries that over the last decade it has changed from a handicraft to a modern industry.

The industry benefited greatly from the development, during World War II, of black plate cans and other substitute cans. They proved very difficult to use for most fishery products, but intensive laboratory research and practical experimentation made it possible to adapt them especially for products packed in oil, so that they could be used with satisfactory results during the emergency.

The tin shortage also made it necessary to introduce electrolytic tinned plate, a development which was so successful that it became permanent. By helping to stretch the tin supplies which are available at present, it is indirectly of great benefit to the industry.

Another development of lasting importance was that of increased use of aluminium containers, especially in the Scandinavian countries (8). The fisheries industries of these countries had already before World War II been active in use of this material. Since, very well designed processes for anodizing and now also lacquering the aluminium plate in bands have reduced the corrosion problem to such an extent that aluminium has become the preferred material for the packing of several items.

It is generally known that the European canning industry before World War II to a certain extent lacked high speed, reliable can closing equipment. This was perhaps particularly true of the fish canning industry where the extensive use of rectangular and oval cans causes special closing problems. Very reliable equipment has, however, been introduced in recent years, giving higher speeds and safer closure. The use of high speed equipment sometimes gives rise to some particular problems because the sealing of the can very quickly after the placing of the lid on it may cause overfilling of cans and buldging of ends. This has been solved in various ways, often by the increased use of clinching prior to closing.

Less extensive use has been made of vacuum closing equipment than was expected before World War II. As far as fishery products are concerned, it is generally recognized that hot filling or exhausting, although more expensive and space consuming, give a more constant vacuum and these methods are therefore mostly preferred.

The quality of the can seams to have also been improved by the now almost general use of liquid sealing compounds.

Improvement is also due to the very extensive use of mechanical can washers, for instance in Portugal. Retorts and processing equipment have undergone very substantial improvements. In several countries, processing in open boilers was used quite extensively before World War II. Pressure processing is now always used and, in the case of Portugal, for instance, it has been made obligatory by law. Pressure gauges, thermostats, and recording equipment on the retorts have been vastly improved, also resulting in much improved keeping quality. Especially the Scandinavian countries have gone in for processing in water under counter or super pressure. This rather expensive equipment was found desirable due to the extensive use of aluminium cans, and very satisfactory retorts were manufactured (9). Other countries have also increased the use of pressure cooling mostly by the use of compressed air.

Continuous retorts have so far found little use in the dish canning industry, probably partly because of the large amount of rectangular cans in use. The continuous retort which was recently developed in France (10) and which uses a high water column to provide counter pressure where cans are introduced or removed from the retort, might be of interest as it can easily be adapted to all shapes or sizes of cans. This retort seems similar to the one designed by a Norwegian company before the war. The latter was, however, never put into general use because of the danger of geyser effect by overcooking, because of rising temperatures, especially in the exit column.

The safety of canned fisheries products, together with better retention of flavor and texture, have been improved by detailed studies of processing conditions, heat penetration, thermal death times, etc..., which have been carried out in many countries.

Fisheries products have also benefited from the more extensive use of cooler storage of can products. This innovation is said to have improved the texture of shrimp canned in Louisiana considerably.

1. Sardines, Sprats, herrings, etc...

The canning of sardines and herring-like fishes mostly follow similar processes and uses equipment of more or less identical design (11).

One of the principal problems is presented by the heading and gutting of the fish. This is quite a labor consuming process, if carried out by hand, and it is difficult to design machinery which will carry it out satisfactorily. Several types of machines were in common use for this purpose in the California pilchard canning industry even before 1938. A machine of Californian design, using a vacuum suction principle for the removal of the viscera, has been used successfully also in the South African pilchard canning industry. The machines from the United States have, however, not found acceptance in places where sardines, sprats or small herrings constitute the major part of the canning pack; these species seem to be more delicate and more difficult to handle in machines than pilchards. In addition, it seems that as they generally are used for rather high priced products, higher demands are made with regard to the complete removal of the intestine.

The Norwegian sprat industry has been in the fortunate position that it generally can free the fishes completely from feed before they are removed from the water by impounding the catch, thus making evisceration unnecessary. Sprat canners in other countries, the sardine industry and many herring canning factories have had to rely on evisceration by hand.

Recently, however, improved machines have been produced by the Arenco Company in Sweden, the Nordischer Machinenbau in Germany (12) and by the Fisheries Research Board of Canada (13). The latter has designed and patented an anchovy gibbing machine which is reported to work very staisfactorily. Machine heading and eviscerating is now used very extensively in the herring processing industries, where large herring is handled. It is used not only for canning, but also for products such as salted herring and herring or anchovy delicatessen. These products are not heat processed and make, therefore, even higher demand on the complete removal of all bones from the fish as the bones are otherwise softened up by the heat processing. Special machines which will not only bone the fish, but also prepare the fish as fillets have been put into use by the delicatessen industries. Another machine which will cut the herring fillets out into small pieces, which are normally used for herring tidbits, has been put into use.

These machines found general use in the last decade in the herring industries, but have proved difficult to use for sardines, sprats, or small herrings. In France and Portugal, sardines have generally been headed and eviscerated by hand. A great deal of work has been put into the arrangement of efficient cleaning tables equipped with mechanical conveyors, often adaptations of the Spanish Masso design. These innovations have led to very considerable labor savings.

However, it should be mentioned that one of the modern French sardine lines, the Toquer line (14) referred to below, uses a heading and gutting system which operates on the fish when it is hung by its tail on the racks in a conveyor system. It is understood that the users of this principle still experiment with it. In addition, experimentation on the design of eviscerating equipment which would work satisfactorily on sardines has been continued. The latest reports from France (10) indicate that workers there recently have experimented with equipment which will carry out the process satisfactorily. It consists of a special roller grader which will carry out the size grading of the fish, which seems necessary for effective eviscerating of fragile fish. Other machines carry out the orientation of the fish and the feeding of them into the heading machine, an operation which otherwise is quite labor consuming. The line is said to be designed for a capacity of 100 to 120 fish per minute.

Other processes which have been in need of mechanization, are the washing, dry salting, so-called rousing, or brining of eviscerated fish. As regards washing, a machine has recently been introduced in France which will wash the sardines placed on the usual frying grills under water jets. It proved to be more difficult to find a satisfactory arrangement for continuous salting or brining. A Norwegian machine has been put into use for the brining of sprats. It consists of a perforated cylinder with internal baffle plates, arranged in a spiral on the inside surface. When the cylinder rotates, partly submerged in brine, these plates move the fish forward. At the end, they lift them out of the brine and place them on a conveyor belt. The machine is very similar to the usual vegetable blancher. The standard models are based on a brining time of 8 minutes.

Brining of sardines and herring generally requires 15 to 30 minutes contact with the brine. Machines of the design here mentioned would therefore have to be quite bulky for these fishes. So far, they have been little used for them.

Most canning of sardines, sprats and herring-like fishes require the removal of a certain amount of moisture from the fish before the can is closed. In the sprat canning industry of the Scandinavian countries, this is generally carried out in combined smoking and drying ovens (15). A special smoking tunnel, designed by the Kvaerner Company of Norway, has found quite general acceptance, also outside of Scandinavia. In Denmark, a rather simple smoking tunnel design by a fish canner is being used by several plants. It uses drying and smoking in counter current air with an initial temperature of the air of 140°C (244°F) and an end temperature of 80°C (176°F). Direct fuel gases are used and 80% of the air is recirculated. Previously, the fish were carried through the oven placed on wire mesh trays on a conveyor system. As these gave undesirable marks on the fish, they have now been replaced by steel plates with holes. Each hole has a wide slit in one side and a narrow slit in the other. The tail or the head of the fish is introduced through the holes and attached in either the large or the narrow slit according to the size of the fish. After drying, the heads or tails are cut off by moving a large knife across the plate, this providing an easy method of releasing the fish.

In some countries, experiments have been carried out with electrostatic smoking. Quite extensive tests were published by the Fish and Wildlife Service of the United States Department of the Interior (16). The fish was placed in the open cans which went through the smoking chamber on a metal conveyor belt. The

smoke was produced by an ordinary smoke generator and chilled with a water spray for condensation of undesirable fractions. It was then lead into the chamber over a grill which formed the positive electrode and was charged with about 20.000 volts. The cans and the conveyor belt, which was grounded, formed the negative electrode. Reports from tests of the product, both from the United States and elsewhere, indicate that its flavor was satisfactory, but it had not acquired the golden color normal for a smoked product. The process never gained commercial acceptance in the United States; it is, however, not unlikely that electrostatic smoking will have possibilities especially as an aid to the smoking as it is carried out in the Scandinavian canning industry where the fish are smoked while hung or laid individually on racks. This gives the possibility of a better contact with the smoke and therby a better color.

It should be noted that recently a German company announced an electrostatic smoking apparatus which appears to be very similar to that tested in the United States. No information with regard to its performance has yet been received.

In the canning or sardines in France, Spain, Portugal, Morocco, etc..., it was generally customary to accomplish the removal of moisture from the fish by frying. In the orthodox process, it was carried out by placing the fish, tails up, in grills which were placed in hot oil or taken through a hot oil bath on conveyor belts. The oil was sometimes replaced by a salt water brine with much the same result. These processes are, however, rather cumbersome and expensive. They were, during World War II, replaced with methods by which the fish is cooked in steam. After cooking according to any of these methods, the fish has to be drained and dried. This process is at present generally carried out in air drying tunnels with forced air circulation (17). Where it is carried out in the open air, special regulations are generally enforced to prevent any contamination of the fish during drying.

The steam processes are difficult to adapt for continuous operation. The development in both France and Portugal has, therefore, aimed at cooking the fish in dry air. This is comparatively difficult to accomplish, as one easily gets an excessive drying of the surface of the fish. However, recently several satisfactory processes have been designed, one which is particularly successful is the Toquer process. An advantage of dry air cooking systems is that one can dispense with the drying period which follows oil frying or steam cooking in the more traditional process.

It appears that the difficulty of excessive surface drying in dry air cooking systems can be partly overcome by cooking in infra red light which gives a very effective penetration of the heat. It is interesting that the rate of penetration can more or less be adjusted by the choice of wave length. The wave lengths normally in use are those close to the wave length of visible light. Several cooking tunnels of this type are in operation in France (17). The infra red light emanates either from electric bulbs or from gas heated steel tubes. The fish are generally conveyed through the tunnels on wire mesh trays. One should in this connection also note the German process referred to below.

One type of equipment which has been of considerable interest to the sardine canning industry is a packing machine which wraps individual cans in waxed paper. Such machines have long been available, but recently an inexpensive one has been introduced by the Lubeca Werke of Germany.

Attempts to mechanize the processing of herring and similar fish

Brief reference is given above to the Toquer system which has been introduced in recent years in France. In this (14) the fish which previously has been brined, is clipped onto a rack on a conveyor belt. This belt carries the rows of fish past a special beheading and eviscerating organ, after which it is washed under a water jet spray. The conveyor then carries the fish through a hot air tunnel, for combined pre-drying cooking and final drying. Where the fish leaves the tunnel, special knives trim the necks and cut the fish off in the proper lengths. They are then carried by conveyor to the hand packing tables. This very interesting type of equipment is reported to have worked successfully for several seasons. The process is in use in two plants in France.

Even radical systems have been designed. They are based on packing the herring raw brined or unbrined in the cans and carrying out the total process of drying, cooking, etc..., while the fish is in the can. This is a great simplification as far as mechanical operations are concerned. Processes of this type have for many years been in use in the California pilchard industry. They were, however, extremely difficult to adapt in the sardine canning where very high demands are made on quality and appearance (17). It is easy to see that it is difficult to prevent the fish from sticking to the sides of the can or one fish from sticking to the other when there has been direct contact during cooking and drying. This problem seems to be particularly important in the canning of sprats and herring because these fishes generally are completely freed from scales. The scales, which remain on sardines, do to some extent contribute to prevention of any sticking of the fish to the can.

Another difficulty is that of getting the fish uniformly cooked and dried when it is not hung individually or spread out in layers or rows on flakes or grills as in the traditional frying, cooking or smoking processes. It was therefore only after many years of experimentation that processes were worked out which were acceptable in the industry.

A third difficulty is that sardines and sprats, contrary to normal usage in the California pilchard industry, are mostly packed in oil. This requires that the product be sufficiently freed from moisture to prevent any separation of water during heat processing. This is very difficult to accomplish in any process which cooks the fish while in the can.

One process of this type, the M and P machine, was introduced by the Mather and Platt Company of the United Kingdom. The fish is beheaded, eviscerated and brined according to traditional methods. It is then hand-packed on modern conveyor-type packing tables in cans which previously have been given an oil coating on the inner surface by the use of a spray gun to prevent sticking. The packed cans pass on a conveyor belt through a hot air pre-drying tunnel which secures firmness of the skin and afterwards on another conveyor into a similar tunnel where cooking is carried out by steam. The cans are then placed by hand on trays which are covered with a wire mesh grill and put in a centrifuge rotating at 450 r.p.m. They then pass into a second hot air tunnel which gives the fish its fried taste and removes any surface water which has not been removed in the centrifuge. From there, the cans go to traditional oil fillers, exhausters - where required - and closing machines. The capacity of this equipment as normally designed is 50 quarter club cans per minute.

Several machines of this type are in successful operation. Five are in use in Morocco. One advantage of the principle is said to be that it is rather flexible so that pre-drying, cooking, drying, etc.., can be varied independently within wide limits.

An even more radical design, the IMC machine, has been developed by the International Machinery Corporation of Belgium (18 a, b, c). The beheaded and eviscerated sardines are packed immediately after washing in cans which have been sprayed with oil. The cans are then placed, generally in rows of eleven, on racks which are covered with a wire mesh grill and attached to the conveyor chains in the machine. Here a preliminary brine is added, whereupon the cans are inverted. This serves to remove blood and undesirable parts. When there are difficulties with the fish sticking together, the manufacturers recommend adding a small amount of acetic acid to the preliminary brine. New brine is now added and the cans are carried through a steam chamber where cooking is performed. Thus cooking is really carried out in brine. The cans are again inverted and dried or cooked first in the inverted position and later in the normal position in air. The cans are inverted once more to remove all liquid freed by the drying and the contents are dried again in the inverted position. This cooking and drying fish while the cans are being inverted several times serves to prevent sticking of the fish to the can sides and to accomplish a more uniform drying. Oil or tomato sauce is added to the cans while they are still attached to the racks; and the cans are taken through an exhaust box which is equipped with a jacketed ceiling which prevents drops of condensing water from falling into them. In some cases the exhaust box is left out. Instead, hot oil or tomato sauce is added to the cans. Where the cans leave the apparatus, steam jets clean the outside of the cans for fat. The racks are automatically removed from the conveyor belt and the cans are released and sent directly to the closing machine. The machinery is made in three sizes, for 25, 50 or 200 quarter club cans per minute. The equipment is already in extensive use; 14 machines of this type are reported in operation in Morocco.

A type or equipment which should be mentioned in this respect is the German so- called Hartmann process by which the gutted, washed and brined fish placed in open cans on hanging trays is brought by a conveyor system through a long cooking tunnel. The cans pass under infra red electric bulbs. The tunnel has two such cooking sections above one another. Coming out of the last of them, the cans are inverted for draining. During this they are covered by a plate with drains in it. They then go through a drying section which forms the third deck of the equipment. Too little is yet known about the performance of this machine to permit any comparative evaluation.

The development of a fourth machine of this type has recently been reported from Morocco (19). It is designed by Daniel BONNEFONT, of Agadir. No drawing of the equipment is available. It is understood that the equipment dries the sardines packed in cans in hot air tunnel, where the cans are inverted all of the time and part of the time in a normal position. The air is introduced into the tunnel and circulated by high speed fans. The capacity of the machine is 25 quarter club cans per minute. It is operated by two workers. The introduction of this machine is of much recent date that no report is available as to its performance. It is understood, however, that it is a quite inexpensive type of equipment, especially useful for smaller canneries.

The above mentioned processes have so far mainly been used for sardines for which they were originally designed. It appears that they may find increased use for herring as well. Mather and Platt lines and some of the International Machinery Corporation machines are already in operation for herring, although an experimental run in the United Kingdom of one of the latter was discontinued. This was probably mainly due to the fact that this type of processing gives a higher percentage of shrinkage than normal herring canning. It is likely that soon the improved quality which goes with this additional shrinkage will make it possible for the product to attain the corresponding higher price. At least one machine of this type is operating successfully on herring in Belgium.

2. Canning of larger fish

Comparatively little development has taken place with regard to processing equipment for larger fish. However, in the production of canned tuna in France (17), the Toquer system mentioned above has been used very successfully. Here the fish which is cut out in steak-like pieces is placed in a ring shaped mould which is carried on a conveyor through the cooking and drying tunnel. The fish is then transferred from the mould directly into the cans. However, many canners claim that any such process where the tuna is cooked in steam or dry air gives less satisfactory products than cooking in brine where spices may be added.

For tuna which has been cooked according to the traditional process, a filling machine has been produced (17). Here, the cooked fish is placed on a rather long cylindrical mould which opens up sideways. The cylinder is then closed, a plunger presses the fish forward until the slices, which fit right into a can be cut off. A similar machine has been developed and put into use in the United States.

A product which has been developed in France during the period covered by this report is tuna packed in brine, so-called "au naturel". The manufacture of this product has not given rise to any particular type of machinery, but has been well mechanized as regards the arrangement of cutting tables, conveyors, packing tables, etc... In addition, a machine has been designed in France which will slice the raw tuna.

For mackerel, special steaming machines have been designed in Denmark. One type is equipped with steam jackets, the fish being placed in a chamber with a layer of water on the bottom. Another uses a bell like chamber which is lowered over the rack with the mackerel and closed airtight with water.

Another development in processing of products from larger fish is adopted in Sweden where automatic fillers for cod roe paste packed in tubes are used. This product is not heat-processed.

3. Crustaceans

Some progress has been made in canning crustaceans and has been reported in the technical literature. In the United States, several automatic deveiners and graders have been introduced for shrimps. A

shrimp grader has also been developed in Australia. The introduction in the United States of shrimp peeling machines may be important. The principle used in these machines is one of passing the shrimp over a layer of thin rollers. The shrimp is pressed against the rollers by rubber or leather fingers or springs. Sooner or later during the passage, a corner of the shell is caught by the rollers and torn off while the flesh passes over the rollers without being drawn into them.

An important improvement in the canning of crawfish was introduced in the Union of South Africa (20) where research proved that the non-enzymatic frowning of the canned product is generally due to reducing sugars. The content of these can be reduced by soaking the crawfish in sea water for up to 15 minutes prior to canning. Soaking exceeding this period should be avoided as it may lead to loss of flavor.

V. NEW PRODUCTS

It can hardly be said that any new canned fishery product which has given rise to entirely new industries has been produced during the last 12 years. Nevertheless, existing canneries have experimented with a large number of new products, some of which may become very important commercially.

One of the most important developments is probably the canning of boneless, or boneless and skinless sardines in Portugal. This product found a ready market in the United States.

Much importance is also attached to the development of a boneless and skinless salmon pack which was produced recently in Canada (21); it is said to receive very good response from the consumers. Salmon canners have also experimented with the introduction of salmon croquettes and other speciality products.

United States tuna canneries have put on the market a lemon flavored tuna and tuna packed in jelly; the company has put up an entirely new canning line for strained tuna which is being used as baby food.

Baby food is also being prepared in the United States from salted codfish. The same company has put on the market canned codfish which has already been soaked and is ready for use. This product is designed to replace the ordinary dried salted codfish which seems to be losing popularity on the market, at least in the United States.

The California pilchard canners have experimented with pilchards packed in a special ginger sauce, with flavouring the pilchard with liquid smoke, and with dry packed pilchard in round cans, a so-called tender-loin pack.

The canning of squid has been increasing in the United States and in Scandinavia. It is interesting to note that in Monterey, a port which is mainly known for its very large landings of pilchard, the total value of the landing of squid exceeded that of the landings of pilchard for the year 1946.

In the Union of South Africa, canned green abalone is being produced (22). It was found that a preliminary salting of the abalone for 24 hours with subsequent soaking removed much of the usual toughness of the meat.

A similar salting process was found beneficial in the Australian canning of Arripis trutta, the so-called Australian salmon (23). It was found that the color of this pack which often is brownish can be considerably improved by the addition of nitrite.

In the United Kingdom, a new product was developed recently when the canning of pilchard was taken up in Devonshire and Cornwall.

In Norway a process was designed aimed at the improvement of the flavor of canned herring. The pH of the product is adjusted to about 6 and a reducing agent, for instance ascorbic acid, is added. Experiments have been carried out in many countries, for instance in Denmark, with the use of monosodium glutamate which is used in some canned products as a flavor improving ingredients. The product was found to have no effect except in the case of fish balls and shrimp where a slight improvement was noted.

In Germany, the canning of herring fillets has been increased very substantially and many new sauces have come into use. It is said that sauces which are completely stable during heat processing have been produced.

A special development, which was of the greatest importance, was the introduction during World War II in Norway of polymerized herring oil, the so-called sild oil, which was used very extensively for canning. During the war years, when no vegetable oils were available in Norway, this product was of the utmost importance for the canners. The product, when well prepared, is completely odorless and tasteless; nutrition experts seem to agree that its addition is not objectionable from a health point of view. It is a very inexpensive canning oil and after a brief recess due to a certain reaction to war-developed "substitutes", it is now being used quite extensively. It is said that certain markets even prefer this oil to the usual vegetable oils.

VI. SANITATION

As operations often had to be carried out in rather small plants, far removed from the main population centers, the fish canning industry was probably somewhat slow in realizing the need for a high degree of hygiene and sanitation. However, the last decade has seen great improvements in this direction. Fish canning plants are now mostly modern and well designed with all the necessary sanitary precautions. Wide use is made of the newly developed synthetic cleansing and wetting agents. Chlorination of water supply and cleaning water is very often used, often together with a special chlorination arrangement for can cooling water.

Fish canners generally receive their raw material in returnable wooden boxes. These are difficult to clean and have recently been replaced in some instances by aluminium boxes or special kits; where wooden

boxes are used, they may be desinfected before being returned to the supplier. In this connection, it might be mentioned that the tendency, especially among the Scandinavian sprat canners, goes in the direction of the use of lower transport boxes where the damage to the fish due to pressure from above lying layers is minimised.

In some sardine canning industries, of Portugal for instance, non metallic grills for sardines have been replaced entirely with iron trays which are tinned yearly with special precautions taken to prevent any addition of lead to the tin solution. Special washing machines have been introduced for the cleaning of these trays between each use. These and other measures taken in Portugal (24) have resulted in the elimination of traces of lead from the product. Thus, the fish may no longer be cooked in the ovens in the retorts used for the heat processing of the cans, otherwise there may be danger of contamination from the lacquer on the outside of the cans, etc.. Also, cans with solded ends have been almost completely replaced with drawn cans or cans which have rolled-on ends. Another important step which has been taken in Portugal to improve sanitary conditions has been to forbid the reduction of waste, etc..., in the same plant as that in which the canning operation takes place.

VII. INSPECTION SERVICES

The inspection services which various countries maintain to improve the quality of canned fishery products have been considerably improved. A new fish inspection laboratory has been established in Canada. It not only carries out a very thorough examination of the canned products, but it also publishes recipes giving recommended practices for the canning of various products, etc...

Much of the improvement of the Portuguese canning industry has been carried out with the assistance of the inspection service of the laboratory of the Portuguese Institute of Canned Fish.

Tunisia has established an export grading of all canned fishery products and the Union of South Africa has formulated very detailed standards for such products. These standards are not compulsory, but most canners find it to their advantage to comply with them. Both Denmark and Sweden have newly established very extensive laboratory control and inspection systems for exported products.

VIII. RESEARCH

The industry has largely been aided by existing research institutions, most of which have been very considerably enlarged. Many new institutions have also been established. A few years ago, there was established in Sweden the Food Preservation Institution which serves the whole Swedish food industry and devotes a large amount of work to the canning of fishery products.

Research work in this field has also been initiated in the United Kingdom by an experimental plant put up in Aberdeen by the Ministry of Food and at the Herring Industry Board's experimental herring canning plant in Port Glasgow.

The fishing Industry Research Institute, established after World War II in the Union of South Africa, has contributed very considerably to the remarkable development of the fish canning industry there.

A new fish canning research institute has been established in Vigo, Spain. The canning industry is also added by the increased biological research activities with regard to the availability of raw material, finding new fishery resources, etc... Most notable here is probably the very large Pacific Oceanographic. Fisheries Investigation program of the United States which is aimed at the finding of new fishery resources and determination of the best fishing methods and grounds, etc.., in the Pacific Ocean. The program is probably of particular interest to the tuna canning industry, which is also aided by the research work planned by the International Tuna Commissions established between Costa Rica, Mexico, and the United States for the purpose of biological tuna investigations.

IX. PROBLEMS SHEAD

Some radical new processes which may influence the methods of canning of fishery products very substantially are at the moment being investigated.

The use of X-rays, supersonic waves and cathode rays, etc.., have always fascinated the food preservation industry. If such a method could be found which would eliminate the need for heat processing, very great progress indeed would be possible in the field of food preservation. Interesting results have recently been obtained with the use of cathode rays. Short periods of radiation of fish in layers up to 5 centimeters (2 in.) can render the fish flesh completely sterile. It has, however, no harmful effect on the enzymes which means that the fish is still subject to enzymatic deterioration (25). So far, no ways have been found to overcome this difficulty.

Many fishery products are quite easily damaged by excessive or even normal heat processing. There have been recent experiments in the United States with the addition of antibiotics to the canned products to reduce the required heat processing. The treatment has not yet been found feasible for commercial operation but the method may, if developed, bring about very great improvements. Other countries have experimented with similar processes using not antibiotics, but other chemicals added in minute quantities. Extensive preliminary tests have been very promising, but detailed information will not be released, until further control experiments have been concluded.

X. CONCLUSION

In comparison with other fishery products, canned fish is extremely easy to store and distribute. This probably accounts for the fact that canned sardines and canned salmon have been very popular in many economically less developed countries. They are inexpensive, staple and acceptable to a great many consumer groups. Unfortunately, there are still large amounts of fish supplies which are fitted for canning, but which are unused. It may be that more consideration than heretofore has to be given to local taste preferences etc.. It is also likely that much of the work to be done is more one of getting markets organised and getting trade agreements and trade channels established. Nevertheless, it is a field where there seems to be possibilities. It is to be hoped that a deliberate effort may be made to have them realised.

It is also likely that much wider use could be made of canned fishery products in the economically more developed countries. It is worth noticing that several fishery products, for instance sardines, tunas etc.., are actually improved by canning. It is likely that this may prove to be the case for other species, which are not, or only sporadicly, canned at present. Here again, it is probably a problem of marketing organization. In addition, the problem may be one of developing new products which better suit the modern housewife and the taste of the modern consumer. This is a field which offers a challenge, but also wide possibilities, for the food technologist and the fish canner who probably should cooperate with chefs and home economics experts.

When looking at the prospects for any such future development, one cannot help feeling impressed by the enormous difficulties which one will encounter. For each little development or innovation, many trials and errors are necessary and even then, progress is slow, often so slow that it may discourage the persons. In such cases, it may be useful to review as has been done here the activities of the past years. One will then realize that by a large amount of small trials and may be big errors, by many attempts and about as many failures, enormous progress has been made. Today, many more research workers, canning technologists, administrators, marketing specialists, etc.., are working on the improvement and promotion of canned fishery products. It seems that by the deliberate effort of these combined forces, the progress within the next 12 years may be much larger than in those here reviewed; that means that it may be truly remarkable.

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V. TECHNICAL PROGRESS IN THE CANNED MEAT INDUSTRY

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Progress in the canned meat industry during the last twelve years has not been spectacular. In an old-established industry such as this, which has been developed by gradual stages, truly revolutionary changes seldom occur. There is, of course, evidence of improvement, resulting from a better understanding of the difficulties encountered. These are frequently overcome by prolonged scientific research, and the salient facts emerging therefrom are gradually applied in practice. Even then it may be many years before the practical knowledge gained can be economically utilized by the employment of equipment and methods based upon such findings. Often the incentive arises from the economic necessity to produce a cheaper article or one designed for a specific market.

It is therefore appropriate to preface any review of the meat industry's technical development during the last twelve years with an outline of the principal scientific work performed. This will be mainly of a bacteriological nature, since the preserving of non-durable meat amounts to destroying or rendering inactive any infection which has either been present from the start, or has entered the raw materials during processing. The destruction or inactivation of microorganisms is rendered difficult by the high standard of quality demanded of a preserved product. In many cases this consideration excludes sterilization capable of killing all microorganisms.

I. SCIENTIFIC RESEARCH

The bacteriological problems attending the sterilization process may be divided into three groups :

1. the effects of heat on the bacteria. This covers all problems relating to heat resistance on the part of the vegetative cells and the spores, and those relating to so-called dormant spores and sporulation;
2. the problems connected with heat transfer from the sterilization medium to the contents of the can;
3. the effect of evacuation on keeping quality.

1. The effects of heating on the bacteria

a) The logarithmic rate of destruction curve

When a spore suspension of some bacillus is subjected to a heating process which brings about killing it is found that the "time-surviving spores" curve which can be plotted shows a logarithmic trend. If the graph is then drawn on semi-logarithmic paper the rate of destruction curve will be represented by a straight

(+) These data are taken from a lecture by Mr W.A.A. BLANCHE KOELENSMID.

line. If like STUMBO (1) we take as the unit of time that time required to traverse one logarithmic cycle say Z, the following table with accompanying graph is obtained (fig. 1).

Time expressed in Z-values	Number of surviving organisms
0 Z	1,000,000
1 Z	100,000
2 Z	10,000
3 Z	1,000
4 Z	100
5 Z	10
6 Z	1
7 Z	0.1
8 Z	0.01

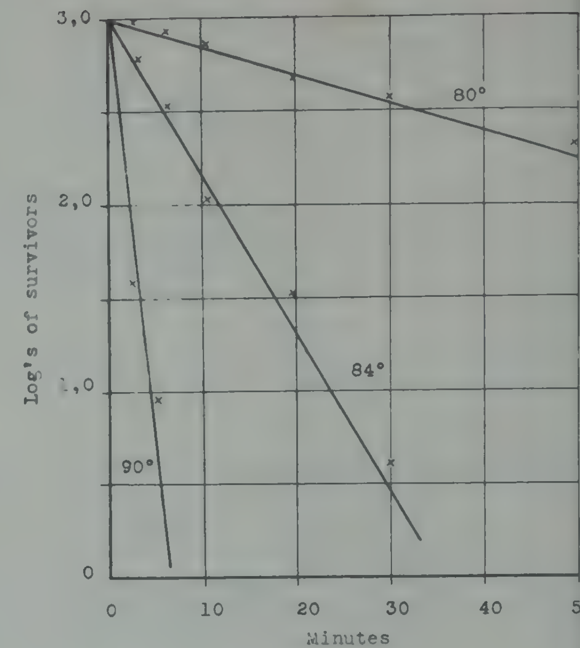

Fig. 1.

For practical purposes an important conclusion can immediately be drawn from this, viz. the effect of a sterilization process is materially influenced by the initial degree of infection. The more seriously the product to be sterilized is infected, the longer one will have to heat. This means that in practice one will have to ensure, by selecting the right process and by observing all the rules of hygiene, that this initial degree of infection is kept as low as possible. In this respect the following tables I, II (2), and III (3) are eloquent.

TABLE I. EFFECT OF SPORE CONCENTRATION ON STERILIZATION

Number of the culture	Initial concentration of spores per cm^3	Minutes required to destroy spores in the same medium at 120°C
	40,000	12
26	3,800	10
	440	9
	130	7
	130,000	18
4019	13,000	17
	1,300	15
	130	11
	50,000	14
4112	5,000	10
	500	9
	50	8

TABLE II. EFFECT OF SPORE CONCENTRATION ON STERILIZATION

Number of the culture	Initial concentration of spores per cm^3	Minutes required to destroy spores in the same medium at 115°C
	45,000	65
26	4,300	35
	400	28
	40	22
	35,000	42
1390	2,550	26
	275	21
	58	10
	35,000	50
1421	1,000	28
	100	18
	13	10

The last example, taken from practice, clearly indicates the difference in spoilage of cans containing corn and sugar in which many "flat-sours" are present (A2 : 2,500 spores per gram) and of those containing sugar only slightly infected (A1 : 60 spores per gram).

TABLE III. EFFECTS OF HEAT ON MICRO-ORGANISMS

Spoilage in cans of corn (No.2) due to the presence of "flat-sour" bacteria in sugar.
Sugar A_1 contained approximately 60 "flat-sour" spores per 10 g
Sugar A_2 contained approximately 2,500 "flat-sour" spores per 10 g.

Processed at 250°F	Percentage of spoilage in corn with		
	No sugar	Sugar A_1	Sugar A_2
70 minutes	0	0	95.8
80 minutes	0	0	75.0
90 minutes	0	0	54.2

b) Effects of the medium

The thermal resistance of micro-organisms is greatly influenced by the nature of the medium in which they are cultivated and by the medium in which they are heated.

NOTA : Figures between ( ) refer to Bibliography, p. V - 8.

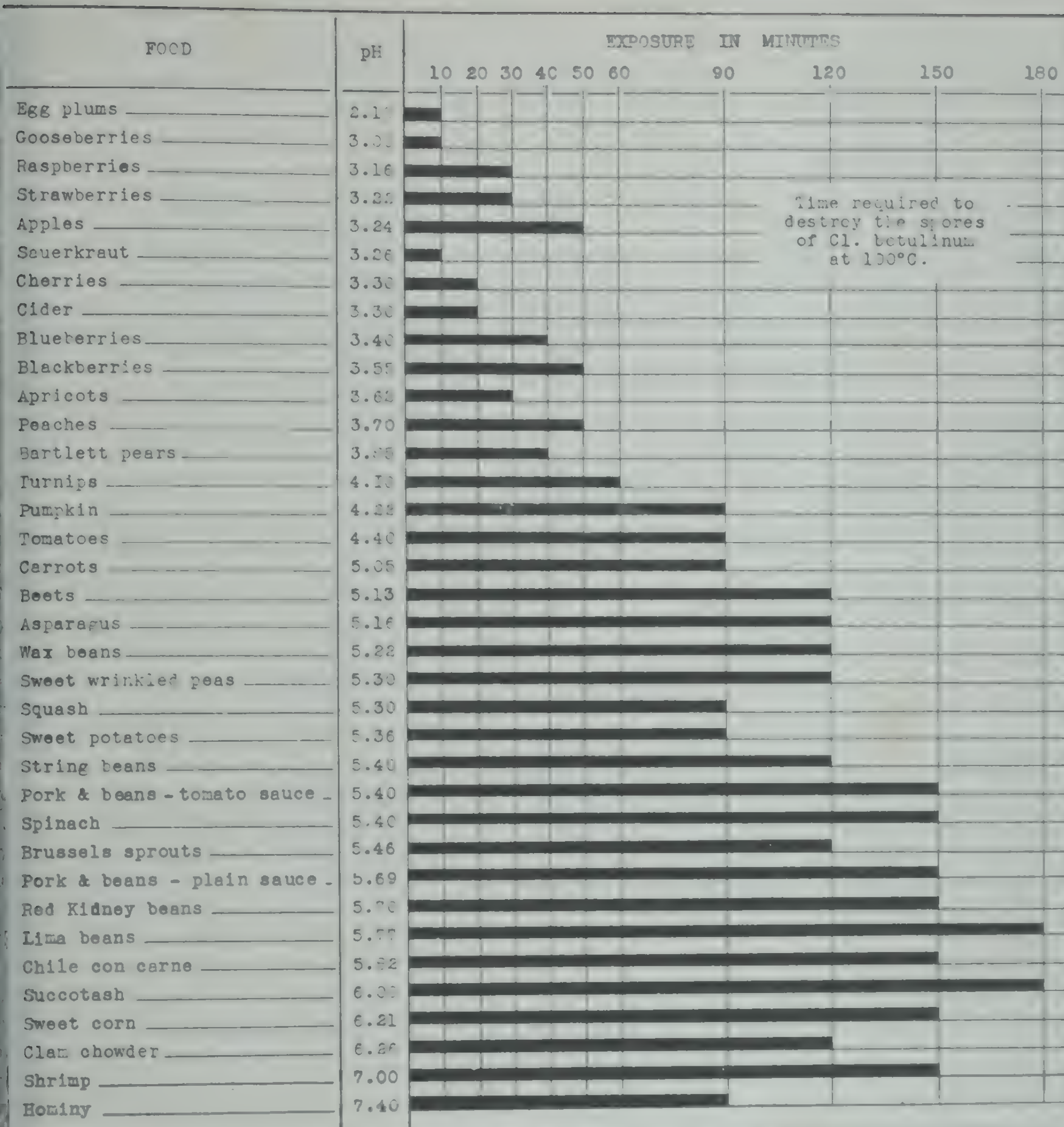

Fig. 2. Chart showing pH value of various foods and the effect of variation of pH value on the thermal resistance of spores of Cl.botulinum.

The experiments of VINTON et al. (4) are interesting. They showed that the thermal resistance of the spores used (a strain of Clostridium sporogenes) was greater when these were formed in pasteurized meat than in raw meat. The resistance was even greater when the spores were formed in sterilized meat, the increase being as much as threefold in comparison with raw meat.

The findings of SUGIYAMA and DACK (5) were essentially the same, but they made the additional observation that Clostridium botulinum spores formed at 37°C have a greater thermal resistance than those formed at 41°, 29°, or 24°.

Moreover, VINTON found that meat which has been heated and still contained living spores, did not go bad. Here we are faced with the unsolved problem of dormant spores.

The pH affects considerably the thermal resistance, as is evident from fig. 2. The optimum resistance of Clostridium botulinum is at a pH of approximately 6.0.

Small amounts of salt promote the thermal resistance, but larger quantities have a reverse effect. For Clostridium botulinum the optimum is 1 - 2 %; above 8 % inhibition is almost complete. For Clostridium Welchii the optimum is 3% salt and inhibition is first evident at 10 % salt.

Opinions differ as to the effect upon the thermal resistance of nitrate and nitrite in the minute quantities which may occur in meat. YESAIR and CAMERON (6) found some effect, STUMBO (7), on the other hand, was unable to detect any.

2. Evaluation of the sterilization process

To evaluate the sterilization process, BIGELOW in 1920 evolved a graphical method which is known as the "General Method". The thermal death time curve of a test organism is determined. For this purpose a certain strain of Clostridium sporogenes No. 3679 of the National Canners' Association Research Laboratory is used, it being the most resistant putrefactive bacillus encountered as a source of spoilage.

The time necessary for all spores of this test organism to be destroyed was measured at a number of temperatures. These points can be plotted on semi-logarithmic paper, giving a straight line. See fig. 3, page 4.

A test can of the product to be sterilized is placed in the sterilization bath with a thermometer or thermocouple in the centre (where heat has most difficulty in penetrating) and the course of the internal temperature with time is measured. See fig. 4, page 5.

BIGELOW attributes a "lethal rate" to each temperature on the graph of the heat penetration in the can. This is the reciprocal of the destruction time from the thermal death time graph. If, for instance, the destruction time is 38.6 at 110°C (Cl. sporogenes) then the "lethal rate" at 110°C is 1/38.6 = 0.026.

A fresh graph is now constructed in which for each moment of the sterilization process the appropriate "lethal rate" instead of the temperature at the centre is given, so that an impression of the total destructive effect is obtained. For this, all values are summarized, i.e. the area between the curves and the time axis in the graph is determined. For complete sterility this area will have to have at least the numerical value of 1. In practice a safety margin is allowed so that the figure is generally 1.4 - 1.5; in special cases for army supplies 2.6.

This method is laborious as one always has to calculate two curves, besides which the experiment must completely correspond with conditions in practice. It can be simplified as do SCHULTZ and OLSON (8)

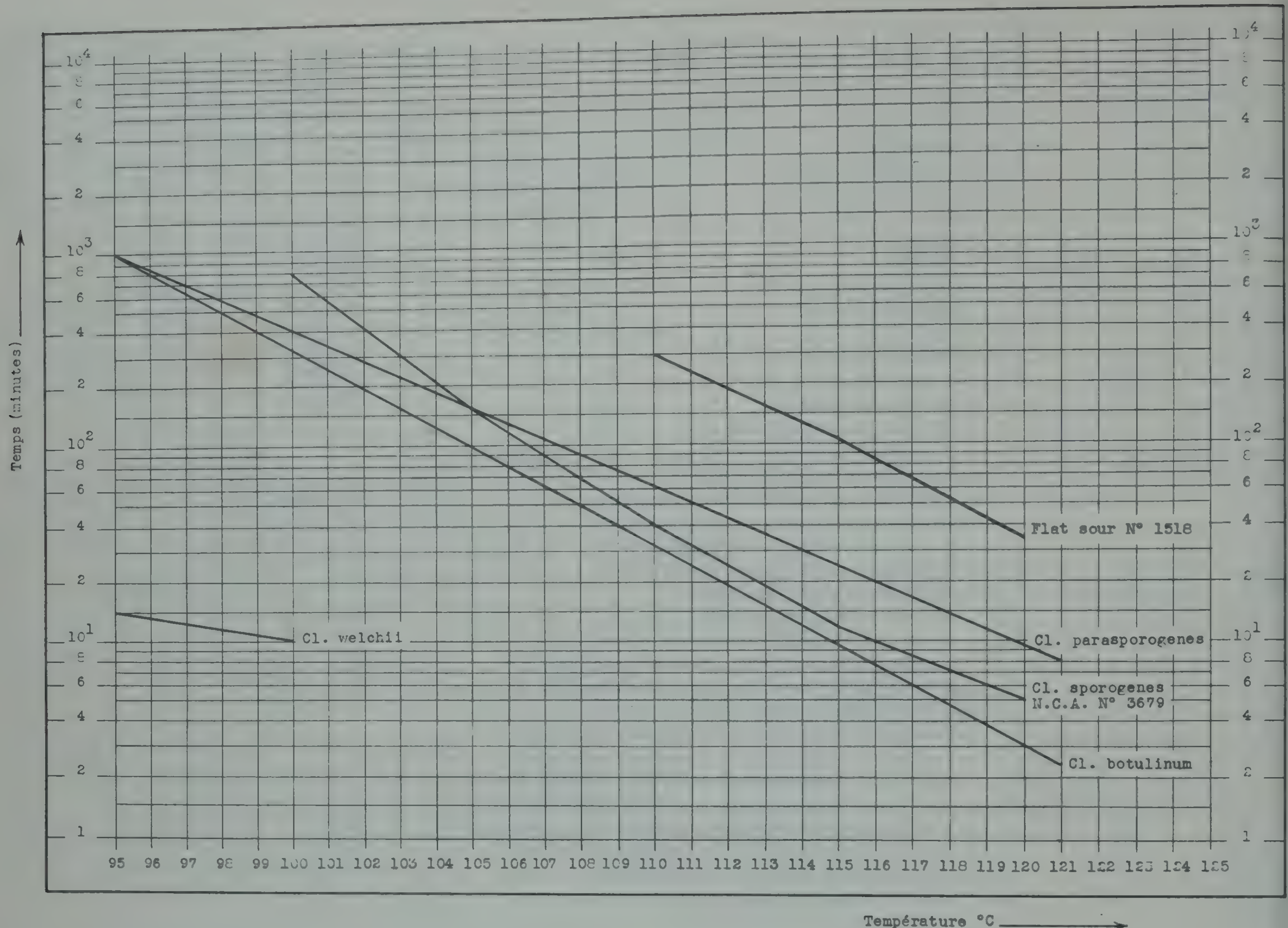

Fig. 3.

by using special graph paper on which as vertical temperature axis instead of a normal linear scale the temperatures are given according to their " lethality value ". The area between the curve and the time axis can then be measured directly in order to determine the killing effect.

In cases where the heat penetration curve plotted on semi - logarithmic paper can be represented by one line or two intersecting straight lines BALL (9) has developed a mathematical formulation of the sterilization effect achieved, which is too complicated to dwell upon here.

If the heat penetration curve on semi-logarithmic paper is represented by one straight line use can also be made of nomograms (10). These nomograms enable one to answer such questions as :

(1) What sterilization time is needed for complete destruction ?

(2) What destructive effect is obtained for a given sterilization time ?

(3) How long does one have to sterilize at a given temperature to attain a desired temperature at the centre ?

(4) What is the temperature in the centre of the can for a given sterilization time ?

STUMBO (11) very recently has presented a criticism on these theories. BALL calculates the time needed for complete destruction of the test organisms at a given temperature. STUMBO points out that this reasoning does not take into account the fact that one cannot speak of an end point of destruction, but that owing to the logarithmic trend of the survival curve only a certain degree of destruction can be reached. STUMBO accordingly defines the time factor as the time needed at a given temperature to reduce a known number of spores of the test organism to a given small number of survivors after the heating process has ended. Neither has BALL taken into account the initial number of organisms to be destroyed.

From the heating test STUMBO determines far more accurately than investigators before him the real effect obtained from the thermal death time point.

The decisive factor in the success on the sterilization process will be the concentration of spores of the most heat-resistant organism. Cases may occur where under conditions of heating these are all destroyed, whilst this does not happen to a far greater concentration of less resistant organisms. To determine the sterilization time one should therefore really know the species of organisms and their numbers.

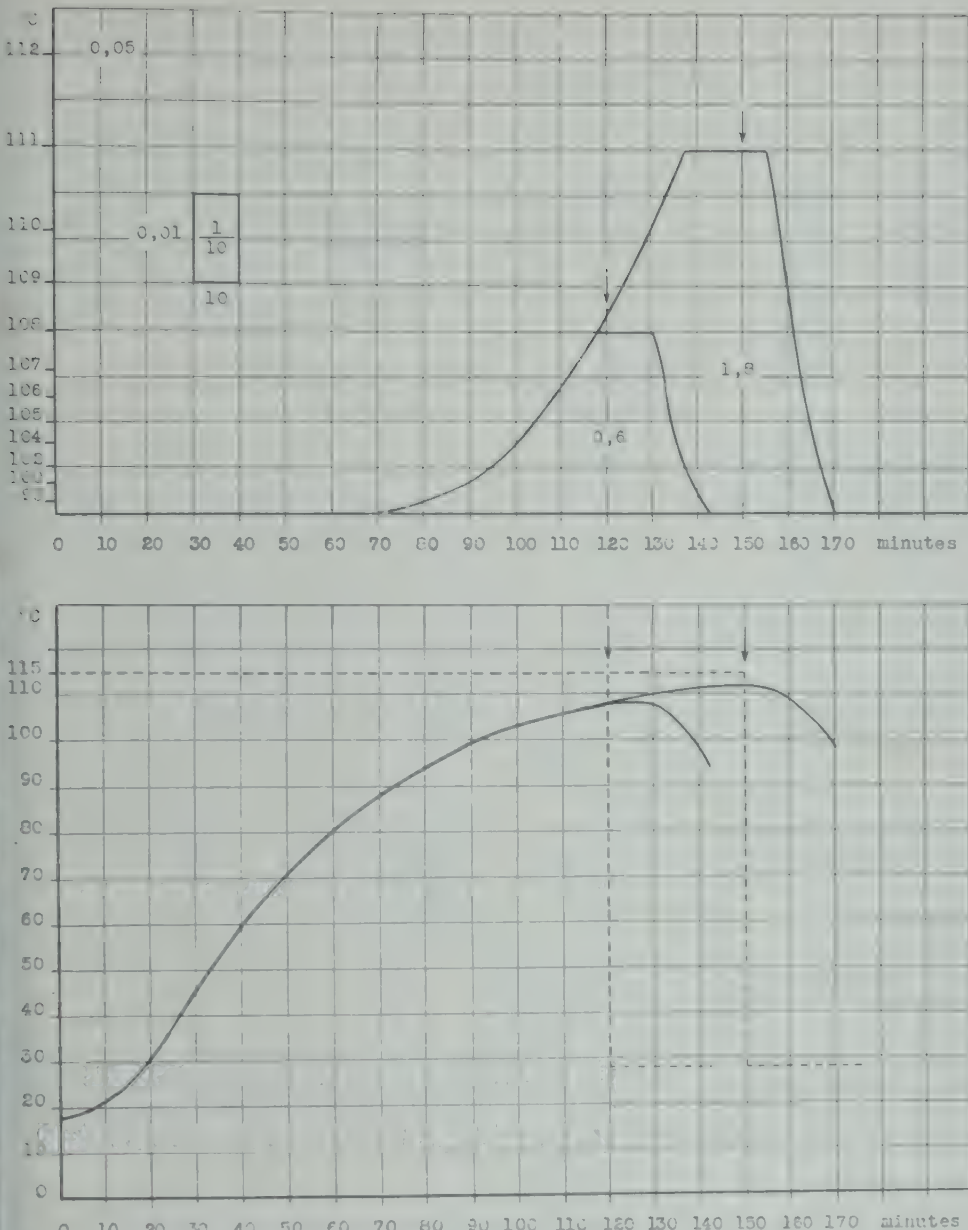

Fig. 4.

Though far more accurate, this method is in practice too cumbersome. When processing a raw material into a canned article one cannot always determine the species of the organisms and their numbers. The bacteriological work involved takes too much time. Hence one has to resort to the more simple method of BALL to compute the sterilization time for a given can, starting from the experimentally found time for a can of other dimensions and identical or similar contents.

If the heat penetration curve is experimentally determined for a can of known dimensions two variables are obtained, one dependent on the nature of the product and one dependent on the dimensions of can used.

When the value of these two variables and the initial temperature are known for a product which is to be sterilized, the time necessary to reach a given degree of sterilization can be calculated for different autoclave temperatures and any desired sizes of cans.

BLANCHE KOELENSMID has verified BALL's formulae for canned meats of various compositions. He found good agreement between the values of the variable which is dependent on the dimensions of the can as determined experimentally and as found by calculations based on BALL's theory.

The table IV (page 6) gives the values of these variables, designated by the letter f_h, both calculated and determined experimentally, and the difference between both.

Using the values of the variable f_h and the value of the variable dependent on the nature of the product to be sterilized, then with the help of the rate of destruction curve of the most resistant spores an answer can be given to any question concerning the effect of the heating. The time and the temperature necessary to obtain a given degree of sterilization can then be calculated.

3. The effect of the vacuum on the keepability

The first and most important reason for the evacuation of canned meats has been the prevention of too high a pressure in the cans during sterilization which can give rise to considerable deformation and thus results in leakage. This evacuation is therefore used in the canned meats industry mostly for cans with an unusual shape which cannot withstand a high internal pressure, e.g. cans for hams.

However, the evacuation may afford a number of incidental advantages, bacteriological in nature, which we shall now discuss in more detail.

JARVIS (12) emphasized that during sterilization liquid present in the can evaporates, the resulting steam then filling the spaces between the solid pieces and warming them. If these spaces are filled with air the production of the steam will be slower owing to the partial pressure of the air and the heating of the solid parts will therefore also take place more slowly so that at a given time and temperature of sterilization a lower internal temperature will be obtained. Furthermore, owing to the vacuum, the contact between the can and the surface of the meat is improved and thus gives a better heat transfer.

CLARK, CLOUGH and SHOSTROM (13) are of the opinion that evacuation prevents growth of aerobic bacteria and thus also in this respect offer advantages.

SAVAGE (14) comes to the same conclusion, but also thinks that evacuation can prevent the development of anaerobic spore-forming bacteria. Dormant spores of this type may be present after the sterilization. They cannot multiply when complex proteins only are available. If, as a result of the presence of air, aerobic spore - forming bacteria can develop, these with their proteolytic enzymes will degrade the proteins to simpler nitrogen - containing compounds. These in their turn will cause the dormant anaerobic spores to multiply.

Against this explanation is the fact that a sterilized non - evacuated can of meat never contains gaseous oxygen. This is bound by the mass during sterilization. However, it is possible that this combined oxygen can fulfil a similar function in the case of aerobic spore-forming bacteria as free oxygen.

Dimensions of the can	Product	f_h experimental	f_h calculated	deviation
TABLE IV				
159 . 178	liver paste	295	285	-10
152 . 130	liver paste	225	220	- 5
115 . 143	liver paste	155	156	+ 1
99 . 138	ham sausage	118	121	+ 3
99 . 138	liver paste	121	121	0
99 . 119	blood sausage	110	114	+ 4
99 . 119	luncheon meat	117	114	- 3
99 . 119	hash	106	114	+ 8
99 . 119	liver paste	110	114	+ 4
99 . 119	liver paste (10% flour extra)	110	114	+ 4
99 . 76	ham sausage	85	85	0
99 . 71	liver paste	78	79	+ 1
87 . 144	liver paste	100	100	0
87 . 126	ham sausage	92	95	+ 3
87 . 98	ham sausage	85	85	0
87 . 98	liver paste	87	85	- 2
87 . 98	German sausage	82	85	+ 3
72,5. 130	ham sausage	70	70	0
72,5. 130	German sausage	68	70	+ 2
72,5. 63	ham sausage	50	51	+ 1
72,5. 63	liver paste	45	51	+ 6
72,5. 55	German sausage	41	44	+ 3
72,5. 55	liver paste	43	44	+ 1
61 . 144	liver paste	59	52	- 7
61 . 98	German sausage	43	47	+ 4
61 . 98	paste	42	47	+ 5

II. TECHNICAL PROGRESS

We shall now examine the improvement which scientific investigation, the technical development of the machinery, and economic necessity have brought the canned meat industry in the last 12 years.

1. Raw materials during manufacture

The recognition of the fact that the effect of the sterilization process is considerably influenced by the initial degree of infection is necessarily followed by an extremely careful treatment of the raw and already partly processed materials, so that the infection is limited as much as possible.

Care must first of all be taken that the skin of the pigs after slaughtering is disinfected as effectively as possible. This can be done by careful singeing. However, to limit as far as possible the development of micro-organisms still present on the skin or flesh of the slaughtered animal, the latter must be cooled as quickly and intensively as possible in cold storage. Two ends are attained by this procedure : (1) rapid cooling off and (2) drying out of the surface, both of which counteract the development of micro-organisms.

For these reasons nowadays cooling to room temperature while hanging is no longer practiced. The longer time of exposure at higher temperatures assists the development of microbes. It is necessary to put the meat directly into cold storage where there is a rapid circulation of air which removes the moisture directly and which ensures a rapid cooling of the slaughtered animals, e.g. at the centre, from 40°C to 5°C, within 8-10 hours.

The further manufacturing process must be carried out as hygienically as possible by keeping the meat cool, by working with stainless steel tables, aluminium dishes, etc... which can readily be cleaned. Further, as far clothes and hands of the workers are concerned, hygienic principles must be scrupulously observed. Here the rapidity of working in the non-cooled places is a factor of very great importance. This is facilitated by air-conditioning plants in the rooms where the meat is prepared.

2. Equipment for transforming the raw materials into the canned products

The general equipment of the meat industry has not been modified to any great extent but refinements and improvements have been introduced. Stainless steel is used more and more and if it is considered too costly aluminium is used. Further, certain improvements in older techniques have been applied ans there has been a considerable development in the means and conditions of production by the installation of manufacturing lines and the more extensive use of mechanized equipment.

Representative of the above-mentioned development is the use of cutters and particularly of mixers which work under vacuum. These have the advantage that they remove the air beaten into the mass of meat and thus decrease the chance of putrefaction of various products. At the same time, the volume of products such as luncheon meat becomes smaller and the sterilization of small Frankfurt sausages is simplified since there is less likelihood of the skin breaking. Vacuum mixers are preferable to the vacuum cutters for those products which can withstand treatment in a mixer. Moreover, self-discharging cutters are coming into use more and more owing to their great saving of work.

At present in a number of countries of Europe ham is being canned on a large scale for export, particularly to America. The industry has had to adapt itself to this by increasing the output and conforming with the demands of quality. This ham must have little fat, no rind, and a low percentage shrinkage. To ensure a constant salt content and removal of the blood pickling must be carried out via the blood vessels. Scales on which a given percentage of brine is injected are now being used for this purpose more than has been the case. The ham is introduced into the can by special ham presses; the can is closed and then soldered under vacuum.

To obtain sausages of a definite weight, e.g. German stuffing machines which introduce a constant amount of sausage meat into the skin are coming into vogue more and more.

Increasing use is being made of stainless steel tables, trolleys, boilers, etc... Often, in the tables stainless steel or rubber conveyor-belts are present for transporting the product. All this increased

› hygiene and economy of the plant. Hygiene is still further promoted by making use of detergents and sinfectants for the cleaning of the equipment.

Combined proportioning and packing machines are used for canning pastes.

Semi-automatic or automatic machines are being used more and more for sealing the cans. The latter rk at the rate of 120 cans per minute.

In many cases, preference is given to the evacuation of cans for reasons already outlined above. is can be done by soldering the cans under vacuum after seaming, by seaming in a vacuum seaming machine or aming tight with a steam jet. This latter method is less attractive for the packed meat industry, since requires a large space at the top of the can, which is often difficult to achieve. Nevertheless it is used certainty is desired that the cans will not bulge owing to too great a filling together with the pressure air.

The other methods are being increasingly applied, naturally along with mixing under vacuum. Without is last process, closing under vacuum has little point since the air from the product cannot be removed vacuum closing and it comes free on heating.

The cans now have to be sterilized. In Europe this is rarely done in a continuous autoclave which s far too great a capacity for the very numerous products in the canned meat industry. Discontinuous toclaves are used, the temperature and time of heating being checked by recording thermometers. Autoclaves th automatic regulation of the pressure and sterilization time do find increasing use. Autoclaves operang under pressure are also used, particularly for aluminium cans.

The baskets in which the cans are sterilized can be filled by hand or, as is nowadays the case, by rtain auxiliary devices for charging and discharging the autoclave baskets. A typical apparatus of this nd consists of a combination of a hydraulic elevator with an autoclave basket having a movable bottom.

The sterilization time and temperature can be established experimentally, particularly with products ose quality is strongly affected by the heating. But also here the methods for calculating the degree of struction of the bacteria can give a measure of the keepability which is guaranteed by the heating. This even more so for those products which can be rendered entirely sterile. In this case, provided the cans e absolutely tight, complete certainty of sterility is assured.

For this it is necessary to carry out experimental sterilizations with the help of thermocouples, order to study the heat penetration. The most recent type of thermocouple described by ECKLUND (15), is ranged so that the thermocouple and the metal sheath surrounding it do not project outside the can. This ables the cans to be closed normally by the present-day industrial automatic sealing equipment. To determine e destruction curve of bacteria in the meat, use is made of very thin cans, which rapidly attain the correct mperature.

The "High-short" procedure (a short sterilization at a high tempetarure) is not used in the canned eat industry. In this industry one is dependent on the conduction of heat through the solid mass and this an scarcely or not at all be increased by movement. A short heating at a high temperature would not heat the inside of the mass sufficiently. In the first place this would result in an inadequate destruction f the bacteria, but in addition most meats require a heating process, a cooking, to render them edible. This n contrast with fruit juices and milk, e.g. which only need to be heated for storage purpose.

After the heating cooling takes place. This is preferably carried out under pressure so that no reat differences in pressure inside and outside the can occur with all the damaging consequences of leakage nd deformation.

To reduce the chance of infection in the possible presence of leaks, sterile cooling water can be sed which is readily obtained by chlorination and perhaps filtration. The great advantage of this method s shown by the investigations of BLACKWOOD and KALBER (16). The cans were treated in a " collision mahine " so that the seams were damaged. 500 damaged cans were cooled with chlorinated water and 500 with nfected cooling water. 2 x 500 undamaged cans were also cooled with chlorinated and infected water respectivey. The result was as follows :

	No. of cans with putrefaction
Undamaged cans, chlorinated water	-
Abused cans, chlorinated water	2
Undamaged cans, infected water	4
Abused cans, infected water	39

These experiments show quite clearly the danger of abused seams, but more especially the use chlornated water can have.

After the autoclaving the cans are washed in various types of installation. In some cases these are provided with a drying zone so that the cans can be directly transported to the automatic labelling machine. It is customary to number the cans.

The store rooms for the cans are much improved and mechanized. The filling of the carton with special machinery and their transport by means of lifting trucks is frequent. The control of sterilized cans has been improved greatly and for this purpose qualified bacteriologists and food technologists are being used more and more. The checking of sterilization by incubation has become classical. A few samples from each batch are taken and are judged after being held for some time at 37°C. If bulging takes place its origin must be traced in the bacteriological laboratory. Large factories cannot do without such a laboratory.

In many countries, cans, particularly those intended for export, are checked by an authority set up either by the government or by an organization from the industry.

III. FUTURE PROCESSES

In this lecture first the scientific investigations were set out and then applications arising therefrom which have now been realized.

Finally we may mention a number of procedures which occupy an important place in present-day research since this can give us an indication of future developments. The processes involved are high frequenc sterilization and sterilization in the presence of the antibiotics.

1. Sterilization by high-frequency irradiation (17)

Sterilization by high frequency irradiation is carried out either by direct application of electroni energy (sometimes called ionizing irradiation) without any appreciable heating or by induction heatin -rays, X-rays, and radio frequency electromagnetic waves are used to obtain very differing effects. study of this method of sterilization is the aim of a large programme of work being carried out at the Mas sachusetts Institute of Technology (M.I.T.) under the aegis of firms belonging to the food industry. A bi campaign of experimental research on electronic sterilization in the cold has been carried out in the labo ratory of the " Electronized Chemicals Corporation " at Brooklyn, New-York. Other laboratories in Americ and Europe are pursuing experiments on high frequency sterilization which depends on an even heating throughou the whole mass by means of induction heating.

2. Preservation with antibiotics (18)

Towards the end of 1949 the use of the antibiotic subtilin simultaneously with moderate heating wa suggested for the preservation of certain foodstuffs which up till now have been preserved by sterilizatio at high temperatures. A great interest in this new method has been raised by numerous articles in the pro fessional journals. Later research, however, has shown that subtilin along with moderate heating cannot b relied upon to destroy the spores of Cl. botulinum or those microbial species generally responsible for th alterations taking place in weakly acid preserved foodstuffs, which are generally sterilized by heating t a high temperature.

Although the results of recent studies have not borne out the promising results announced by th original investigators and although the employment of antibiotics would raise questions which can only b answered by large-scale research, most bacteriologists in the industry are agreed as to the desire of con- tinuing the study of the problems.

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VI. TECHNICAL PROGRESS IN THE VEGETABLE CANNING INDUSTRY THROUGHOUT THE WORLD DURING THE LAST 10 YEARS

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Reports prepared in various countries (1) show that during the last 10 years the evolution of the canning industry has been directed towards an improvement of the organoleptic and nutritive qualities of its products as well as towards a reduction in their cost, with a view to making them available to the greatest possible numbers of consumers.

In the vegetable canning industry efforts in this direction have been made both as regards raw materials and the manufacturing processes through the perfecting of the technical conditions of handling and the improvement of methods of production.

As regards raw materials, the tendency has been to develop the control of quality and the selection of suitable varieties for canning on the following basis :

- uniformity of appearance and flavour;
- good resistance to disease;
- high yield;
- uniform ripening;
- suitability for automatic or semi - automatic handling both in the field and in the factory.

Special attention has been given to extending as much as possible the period of availability for canning of the principal vegetables, and in this field, common to both agriculture and the canning industry, an interesting development has been the perfecting of a system of forecasting the harvesting date, known as "Growing Degree Days" based on the relation existing between atmospheric temperature expressed by the average day temperature above a certain minimum temperature varying according to the vegetable under consideration, and the growth of the plant. This system has been developed in the United States for peas and seems to have been applied with success (2 - 4). Work is in hand to develop its use for other vegetables such as Sweet Corn (5), green beans (6) and tomatoes (7).

Finally, much work has been done in developing insecticidal treatments which may result in increased yields and healthy products.

NOTA : Figures between ( ) refer to Bibliography, p. VI.- 12.

As regards the treatment of the raw materials during canning, developments have shown a greatly increased tendency to :

- speed up and standardise the various operations by means of automatic mechanical equipment;
- perfect the methods of handling and improve the efficiency of certain operations;
- improve the conditions of hygiene in the factories both from the physical and the bacteriological point of view;
- use equipment designed to avoid any undesirable reaction with the product (increased use of stainless metals).

The interest shown in the quality of manufactured articles has also led most canneries to set up, or at least to study, minimum quality grades to which their various products must conform. In all these fields the greatest progress has undoubtedly been made in the United States, but most other countries to a greater or lesser extent, have made similar progress having regard to their own special conditions.

To review the chief developments in the vegetable canning industry we will deal successively with the various operations from the harvesting of the raw materials to the final pack indicating for each one the improvements which have been made or are under consideration.

I. THE HARVESTING AND CONTROL OF QUALITY OF RAW MATERIALS

The need for quick handling and reduction of costs has led to increased mechanisation of harvesting methods wherever possible; thus in all canneries which are handling peas, harvesting by hand has been more and more replaced by harvesting and vining the whole plant by suitable machines which are continually being improved.

In the United States machines have also been made for harvesting sweet corn. In the last few years, a further advance has been made in this field by the development of combined harvesters and viners for peas. The first trials have been satisfactory and their final perfecting is at hand. Trials have also been made towards mechanising, at least to some extent, the harvesting of other vegetables such as green beans, spinach, asparagus (8 - 9), etc., by the use of either semi-automatic or completely automatic machines. However, in this field the equipment under test has not passed the experimental stage and no commercial application has yet been carried out.

Parallel with the development of harvesting machinery there should be noted the development of mechanical equipment for handling the by-products, for example, machines to collect and pile the vines and pods of peas.

Increased attention has also been given to objective methods for controlling the quality of raw materials, and suitable instruments which have progressively tended to replace the older chemical or organoleptic tests have been developed. Most of these methods are based on the determination of physical characteristics and amongst the equipment used or suggested to specify the state of maturity or other quality of vegetable raw materials, the following should specially be noted :

- <u>Refractometers</u>

Used for determining the soluble solids in tomatoes and sweet corn (10);

- <u>Succulometer</u> (11)

Regularly used in the United States to determine the state of maturity and quality of sweet corn by measuring the succulence of the seeds from the volume of liquid pressed out of them by a specified pressure during a given time. The volume of liquid expressed under these conditions is directly related to the water content and alcohol insoluble dry matter.

- <u>Tenderometer</u>

Developed in 1937 by MARTIN (12 - 13) and regularly used in the United States and recently in other European countries for determining the maturity and quality of peas. This equipment measures the force necessary to crush the grains by shearing them in a special arrangement of grids. The resistance to shearing is inversely proportional to the tenderness of the peas, and is directly related to their content of alcohol insoluble dry matter.

The tenderometer has also been used to determine the quality of other vegetables such as lima beans.

Other apparatus based on the same principles has recently been suggested :

- the miniature tenderometer (Shear-Press) in the United States (14);
- the maturometer, in Australia (15).

These have the advantages of being less bulky than the usual tenderometer and easier to use, at the same time giving results of greater precision and reproducibility.

- <u>Penetrometers</u> (Pressure testers)

These were originally used for determining the state of ripeness of fruits and are now being tested to measure the degree of fibrousness of certain vegetables such as green beans (16) and asparagus (17). The principle consists in measuring the resistance offered by the tissues to the penetration of calibrated metal rods, blades or wires. This apparatus is, like a certain number of others based on similar principles, the textureometer, fibreometer etc., not yet beyond the experimental stage.

II. THE TRANSPORT OF RAW MATERIALS TO THE FACTORY AND CONVEYING DURING MANUFACTURE

From this point of view the organisation of work in a modern factory is directed towards reducing to a minimum the delays occurring between harvesting and packing as well as to maintaining the product in the best possible condition. These results are obtained by increased speed of transport and handling operations as well as by the cooling of the vegetables during transport and storage. As regards this latter point the following new methods may be cited :

a) transport in cold water for seed vegetables such as peas and beans. Apart from lowering the temperature, this method has the advantage of simplifying handling and unloading operations. However, it may have to be abandoned because of its bad effect on the flavour of the products through extraction of soluble matter;

b) refrigeration by immersion in tanks, or under jets of iced water, to which bactericidal and fungicidal agents have been added. An example of this type of equipment is the F.M.C. Stericooler (19).

Increased speed of handling during manufacture is obtained by the standard systems of continuous conveyors linking up the different machines in the packing line, conveyors, elevators of various types, etc, to which must be added especially for seed vegetables the hydraulic conveying systems which consist in moving the products suspended in water, in closed pipes, or by special lifting pumps (SCOTT, CHISHOLM-RYDER, etc.). This system of conveying, which has been used for some years in the States, is now beginning to spread in Europe. A recent development which is particularly interesting has been noted by HIRST and ADAM (1-c). It consists of a continuous canning line, designed by T.M. JONES, in which all the operations, from washing to filling, with the exception of grading and blanching, are carried out in a current of water, which carries the peas from one stage to another with no mechanical means of handling or lifting.

II. THE WASHING AND CLEANING OF RAW MATERIALS

To increase the efficiency of washing, modern factories use two principal methods according to the nature of the vegetables being treated :

a) washing under high pressure water sprays, in which the action of the water is supplemented by the mechanical force, resulting from its pressure. This system is used particularly for tomatoes, asparagus, root vegetables, etc...

A typical example is the washer now used for tomatoes in which the fruits are carried, under water sprays, by a continuous conveyor with rotating rollers which cause the tomatoes to turn over and over so that their whole surface is exposed to the action of the water sprays.

Another example of this method of washing is the squirrel cage washer in which the product is passed through a drum where it comes under the action of a washing spray mounted in the axis of the drum. A washer and cleaner based on this principle has recently been used at the outlet of a viner (Super Cleaner I.M.C.). The machine consists of a double inclined drum and the peas are fed into the inner perforated drum which retains the waste material larger than the peas; lighter and smaller waste material is eliminated through the perforations in the outside drum under the action of high pressure water jets. The machine thus enables all waste material to be removed from the vined peas without having to employ the normal methods of dry cleaning under air pressure.

Another interesting development is the Stero - Washer (Mather and Platt) which consists in carrying the peas in a vertical bucket elevator, through water jets playing from the top to the bottom and from side to side in order to wash the peas in the buckets (1-c). Cooling under jets of iced water (hydro-cooling), as previously mentioned, can be combined with any method of washing with high pressure water sprays.

b) Washing in a continuous system of recirculating water in the flotation type of equipment used for seed vegetables, such as peas, beans, sweet corn, etc... In these washers (OLNEY, SCOTT, I.M.C. System etc.), the vegetables are carried continuously in a gentle current of water in a hopper shaped trough. The seeds and heavy foreign matter fall to the bottom from where the current of water carries them through a pipe to a rotating sieve where they are washed, under water jets, to remove heavy foreign matter. The light foreign matter floats on the surface of the water, and is carried away through an overflow in the top of the trough. For other vegetables, particularly leafy ones, washing by immersion is carried out in suitable tanks through which the product is carried by various means such as slatted belts, perforated buckets, paddles wheels, screws, etc...

The most recent development in the washing of vegetables consists in the perfecting of methods of foam washing (20) which have been developed since 1946, in the United States.

The method is based on the difference in wettability of the seeds of sound peas and foreign matter which is mixed with them and it consists of passing the product through a bath of a fine dispersion of mineral oil and air, in water, to which has been added an emulsifying and wetting agent. In this bath the sound peas fall to the bottom, whereas foreign matter rises to the top, where it is held by the froth formed on the surface of the emulsion. This process has been applied successfully to peas and is now being used for beans and sweet corn from which seeds attacked by insects, and the insects themselves can be eliminated. Two continuous machines working on this principle have been developed, that of the inventor of the NEUBERT process (21), and another modified and improved one, the KEY (22).

It should be noted that whatever system of washing is used, there is a tendency to increase its efficiency by the use of a bactericide (chlorinated water, or water to which some other oxidising agent has been added). Sometimes detergents or wetting agents are also added to increase the efficiency of cleaning.

As far as air cleaning is concerned, the standard machines have been somewhat improved to allow, for instance, of the cleaning of wet peas (23); a system based on air cleaning and sieving combined has also been suggested (BRÜSER).

IV. PEELING

In these operations a certain number of new techniques have been proposed in place of the standard abrasive methods as used for root vegetables, such as carrots and potatoes, or the hand peeling normally used for others such as tomatoes, asparagus, etc...

These different techniques have the object of effecting a rapid and uniform peeling, of large quantities of vegetables while at the same time keeping to a minimum the amount of waste. A few of them have to be supplemented by a light abrasive peeling or hand trimming. Among the suggested methods are the following:

- Heat peeling (24 - 25)

In this method very high temperatures are applied for a very short time. These produce a surface carbonisation of the skin which is then easily removed by rubbing or by water jets. This method can be applied to sweet peppers and certain root vegetables, sweet potatoes, carrots, etc. In a machine recently built in Great Britain heating is carried out in an electric oven at a temperature of about 1,000°C. This machine can be used for peeling fruits and vegetables (26 - 27).

- Chemical peeling

In this method the products are immersed in a hot caustic soda solution the strength of which varies with the vegetable. This method, normally used for fruits, has been applied on a much smaller scale to the peeling of potatoes in the United States (28 - 29) and of asparagus in France.

- Peeling by high pressure steam

This method has been used for a number of years for root vegetables in the United States (30).

- Peeling by caustic soda and steam combined

This method is carried out by continuous equipment and is used for peeling tomatoes and root vegetables (31).

For peeling tomatoes the use of superheated steam at a very high temperature has been suggested (32 - 33) and quite recently there has been announced the production of an automatic peeling and coring machine for tomatoes - Rollins Automatic Coring and Peeling Machine (34).

V. TRIMMING

In the final trimming is still essentially a hand operation many mechanical devices have been developed for carrying out certain other operations which may be considered as part of the general trimming procedure. The following should be noted :

- mechanical snippers for green beans (CHISHOLM-RYDER, F.M.C., I.M.C., HERBORT);
- a machine for removing the root and stalk of mushrooms (URSCHELL Mushrooms Trimmer) (35);
- a machine for coring tomatoes (URSCHELL Tomato Coring Machine);
- small rotating knives driven by hydraulic turbines for trimming tomatoes, root vegetables, cauliflowers, cabbages, celery, etc... (MAGNUSON HYDROUT) (36);
- semi-automatic equipment for peeling and grading asparagus (ATLAS PACIFIC and HERBORT).

Finally, various machines of American or European design exist for dicing green beans and the various components of macedoine.

VI. GRADING

In this field two methods should be considered :

- grading by size;
- grading by density.

As far as grading by size is concerned the developments consist only in minor improvements to standard machines, thus pea graders with cylindrical drums tend to be replaced by Clover Leaf Drums which give a better spread of the peas, and thus greater efficiency of sieving.

Various improved systems of the squirrel cage type with progressively increasing spaces between their bars have also been developed for grading whole green beans and an entirely new machine (23) based on the use of centrifugal force has recently been suggested for grading cut green beans. Diverging cable graders of the type used for fruit have also been tried for grading certain vegetables such as asparagus.

Quality grading in brine (37) based on the variation of density with maturity is used in the United States for peas, lima beans and sweet corn and has recently been used in Europe both for separating products into several qualities or simply to eliminate those which are over-ripe.

Mechanical brine graders have been perfected and equipped with automatic controlling equipment for the brine density and certain of them (LEWIS, BERLIN-CHAPMAN, CHISHOLM-RYDER) have been completely redesigned. New and entirely original systems have also been seen, KEY (38 - 22).

VII. BLANCHING

Generally, blanching technique has not altered very much since the development of the continuous

drum blancher now standard in the vegetable canning industry. During the last few years numerous studies have shown the advantage of a rapid blanching in the preserving of the thermolabile vitamins, and blanching in steam has also been suggested to decrease the loss of water soluble nutrients. So far it has not been adopted on a large scale.

To overcome certain objections to blanching in the standard continuous drum blanchers, the technique of blanching under hydraulic pressure in tubular blanchers was suggested about 1935 in the United States (1-a). This method was applied to seed vegetables and consists in pumping the product in water using about one part of the product to four of water through a tubular system of horizontal pipes, about 10 cm in diameter. The water is heated by steam jackets round the tubes and by injecting steam into the feed tank. The advantages of this method are as follows :

- ease of maintenance, and cleaner working conditions;
- greater flexibility and uniformity of treatment;
- saving of floor space - the tubular blancher being generally hung from the roof;
- saving of steam;
- reduced time of blanching because of the pressure;
- better cleaning of the product during blanching.

Finally, the most recent development in blanching is the rotary bucket blancher by BERLIN - CHAPMAN (68). This is designed for blanching continuously specified quantities of the product in a minimum amount of fresh water. It avoids certain objections to normal blanching, particularly the destruction of the colour in green vegetables. The plant has been specially designed for blanching peas in the Blair process, the object of which is to retain the natural green colour of the peas.

VIII. CRUSHING, SIEVING AND HOMOGENISING

For these operations, employed in the preparation of juices, purees, creams, soups and baby foods, the equipment used has been developed according to the nature of the product to be handled. Stainless metals are generally used for all parts of the equipment in contact with the product so as to avoid both discolouration and loss of nutritive value. From the technical point of view, hot crushing of tomatoes in the manufacture of puree or paste is normally carried out in order to inactivate the pectinolytic enzymes responsible for destroying the pectic material which influences the viscosity of the products. Heat treatment also has the advantage of helping to eliminate the inter-cellular gases which might harm the quality of the product (oxidation of Vitamin C, destruction of pigments etc..).

Further, for very finely divided products - creams, sieved foods, baby foods, etc..., continuous equipment of the RIETZ Disintegrator and Colloid Mill type are being more and more used. Finally, <u>the resistance to separation</u> of these products has been improved by homogenising them in equipment such as is used in the dairy industry.

IX. CONCENTRATION

In the vegetable canning industry concentration is involved only in the manufacture of tomato puree and paste. The object has always been to operate the concentration process at the lowest possible temperature with continuous production of the concentrate and immediate packing into cans. Various modifications have, therefore, been made in the standard evaporators and vacuum pumps with the object of getting higher and higher vacua and consequently lower and lower working temperatures. Such temperatures, near to or less than 50°C, have made possible the production of concentrates whose organoleptic characters approach more and more to those of fresh tomatoes, and in which there is a greater preservation of thermo-labile nutrients. In order to work at lower temperatures and to obtain continuous production thermo compressors and double effect evaporators have been used in the tomato concentrating industry. In all this equipment copper which previously was used throughout has been gradually replaced by stainless steel. Details of these developments will be found in a recent report by F. EMANUELE (39).

In the United States attempts have been made to prepare frozen concentrated tomato juice. The method is based on the techniques recently used with success on citrus juices preserved by freezing, after concentration at very low temperatures by indirect thermo-compression in equipment of entirely new design in which the principle of the heat pump and ammonia compressor is used (Lo - temp system). It appears, however, that certain difficulties, particularly due to the viscosity of tomato juice, have not yet allowed commercial application of this process.

X. CAN FILLING AND CLOSING

1. Standard methods

Although it is difficult to pick out any spectacular developments in the evolution of the standard methods of filling and closing canned vegetables, a constant progress during the last few years may be noted arising from the perfecting with regard to speed of operation and of ease of cleaning, of existing equipment for filling, brining, and closing.

According to the most recent information (1-a) the latest American machinery for filling vegetables

and similar products is characterised by markedly increased speeds, thus for baby foods and strained foods American fillers working at 400, 54 x 76.2 mm cans a minute are in use. These machines are designed so as to introduce little air into the product and so as to be easily cleaned and sterilized. For peas and sweet corn, fillers working at 300 No. 2 cans per minute also exist. In these fillers the usual order of filling for products consisting of a solid and a covering liquid are changed, the liquid being filled first thus avoiding air pockets. This is particularly important when the liquid is more viscous than water. Closing the cans while hot may be considered at the present time as a general practice in all branches of the canning industry. Its advantages in improved quality and keeping properties, in the appearance of the cans and in the greater rate of heat penetration need not be stressed. According to the product, hot closing has been obtained for many years by adding boiling brine, by heating the product before packing into the can, and above all by the increased use of exhausting. Filling with hot liquid is carried out by various brining machines frequently directly coupled to and synchronised with the fillers. Heating of the product for viscous materials (purée, creams, tomatoe concentrates, etc.) is normally carried out in steam jacketed tubes through which the product is carried by a screw which itself may also sometimes be heated. Modern equipment of this type is fitted with automatic temperature regulators which maintain a constant control on the temperature of the product. Exhausting which previously was mostly only used for fruits is now also used for vegetables particularly in large cans. Since the introduction of continuous sterilizing methods at high temperatures the importance of exhausting has been increased for it permits of a reduction in sterilizing time and thus increases the output of the cooker. Generally speaking, the exhausting of cans has many advantages but on the other hand it has been said to reduce the speed of the line, to have a high steam consumption and particularly to need much floor space. A recent tendency in the canning industry has been to replace exhausting by closing with steam injection (1-a and b and 40).

2. Closing with steam injection

This method, particularly in America, has developed rapidly since 1940 when high speed seamers fitted for steam injection were made available. At slower speeds steam injection was carried out in America long before 1940 more particularly for glass packed products under the name of "Steam-vac" or "Steam-flow" closure, and it was designed to produce a vacuum in the head space of the containers without the use of the usual exhausting process. The procedure consists in injecting a jet of steam under pressure into the head space of the container at the moment when the cover is placed on it. The steam sweeps the exposed surfaces and drives out almost all the air in the head space, then if the container is closed at this precise moment a vacuum is created when the steam introduced into the head space is condensed. The closing of cans with steam injection needs no additional equipment but only an appropriate alteration to the seamers. The steam is injected through specially designed holes in the seaming head. According to BALL (1-a) the best results are obtained using a large volume of steam under low pressure. The steam pressure at the injectors is generally about 10 lbs. per sq. inch. Accurate synchronisation of the various parts of the seamer which control the lid feed, the steam injector and the closing operation is essential. Some further details of this method and of its use will be found in a report by LUECK and BRIGHTON (1). According to these authors steam closing may usefully be applied to carrots, sweet corn, tomatoes and asparagus. Generally speaking it is particularly good for products packed in a liquid which covers them completely. It must be remembered however, that closing with steam injection does not have all the advantages of the standard exhauster and although it may produce a vacuum in the head space, it has practically no effect in increasing the temperature or de-aerating the contents of the can. For canned vegetables which need a high initial temperature or a high degree of de-aeration, the application of steam closing is limited since the mass of the product must be heated before filling.

3. Vacuum closing

The closing of cans under vacuum has been carried out on many products for a very long time by means of special closing machines connected to vacuum pumps. As far as canned vegetables are concerned, packing under cold mechanical vacuum (25" - 28") has been adopted in the United States commercially for some 20 years, but the method known as "Vacuum Pack" is a more recent development based on much experimental work (41). It is used principally for whole grain corn, and on a smaller scale for peas, sweet potatoes, green beans, carrots and beetroot. It has been stated to give better preservation of the organoleptic and nutritive qualities of the pack. The technique of "Vacuum Pack" as used in the United States differs from standard filling methods in that the proportion of covering liquor added to the cans is generally reduced to 10 % or less of the capacity of the can. The object of this is to cut down the losses in water soluble nutritive and flavouring materials (mineral salts, vitamins etc.) a considerable proportion of which are generally extracted by the covering liquid, and which, since this is generally thrown away, results in a loss in the nutritive value of the product. However, this method of packing under vacuum involves a certain number of specific problems connected with heat penetration during sterilisation. Experience has shown that heat penetration is hindered by the effects of the vacuum and the reduced amount of the covering liquor. This is why "Vacuum Pack" products need longer sterilising times than similar products packed normally. This phenomenon results from the fact that in vacuum packed products, the liquid evaporates more in the can. At this moment the vapour acts as a medium for heat transmission in condensing on the solid particles around which it circulates. As the temperature rises this condensation is stopped and the rate of heat penetration decreases. To increase the rate of heat penetration under these conditions it has therefore been necessary to agitate the cans and this will be discussed later (sterilisation and cooling).

4. New filling techniques. Filling in layers and aseptic filling

These two techniques have been introduced into the United States during the last few years. Although entirely different in their principle and method, both have been the main object of increasing the rate of heat penetration and so reducing the time of sterilisation.

a) Filling in layers

This method has been suggested by BALL (1-a, 42) for a pack of sweet corn, which consists of a mixture of creamy, solid and liquid material. It is only applicable to those packs whose composition permits the placing of the components in successive layers in the cans and allows of the liquid and solids phase on the one hand and the pasty phase on the other being kept separate during sterilisation. The final mixing of these phases is carried out after sterilisation by shaking the cans, or by mixing by the consumer when the can is opened. This procedure originally called "Cremogevac" and since 1950 "Strata-Cook", consists in placing first of all the pasty material in the bottom of the can and then adding the liquid and solids phase After closing the cans they are sterilised in the normal manner, care being taken not to shake them. During the heat treatment heat is transmitted inside the can by two different principles, according to the phase being considered. In the solids-liquid phase, heat is transmitted by convection, which rapidly brings the center of the can to the required sterilising temperature. In the middle of the pasty layer on the other hand, the heat is transmitted solely by conduction, but since it is in a relatively thin layer and placed at one end of the can between the metal end on one side and the liquid-solids phase heated by convection on the other, the pasty layer is exposed to heat on all sides and its temperature is raised rapidly to the sterilising point.

According to BALL's date, layer packing would permit of the reduction of sterilising times by 40-50 % as compared with similar products packed normally. Layer packing has been used industrially in the United States in the manufacture of a new type of canned sweet corn called "Cremogenized Corn" (1-a) whose production seems to be increasing steadily. In appearance the product is intermediary between whole grain corn and cream style corn, both of which are manufactured on a large scale. The new product is a mixture of whole grains and cream in a light brine, the cream being made by a preliminary pulping of part of the whole grains. The details of the method of production of "Cremogenized Corn" are given in recents patents (43).

b) Aseptic canning

This method is an integral part of the new sterilising techniques for liquid and semi-liquid products. Sterilisation is produced by flash heat treatment before packing, and will therefore be discussed in detail in the following chapter (Sterilisation and Cooling).

XI. STERILISATION AND COOLING

The technical work on heat sterilisation done during the last 30 years in the United States and still being carried on by BALL, STUMBO, JACKSON, OLSON and others, has prepared the ground for developments in the industrial sterilisation of canned foods and has had a great bearing on methods of thermal treatment, and on the equipment used. It is difficult to separate the development of the method from that of the necessary equipment since in most cases they are closely linked together. We will, however, try in this Report to make this distinction as far as is possible and will consider first of all the new techniques and the equipment for them, then the new equipment developed for applying the standard methods and finally the improvements effected in older types of equipments. As far as new techniques themselves are concerned, the most pronounced tendency for a number of years for products with a slow rate of heat penetration has been to replace low temperature-long time processes by high temperature-short time ones. These have a greater thermal efficiency and are thought to have a less harmful effect on the organoleptic and nutritive values of the product. This tendency carried to its extreme limits has resulted in the adoption of the high-short or HTST method of BALL (44). These methods, suitable mainly for liquid products, consist in heating the product to a relatively high temperature in a very short time (a few seconds to a few minutes), and then cooling it rapidly. However, to obtain a sufficient rate of heat exchange it is necessary to handle the product in very small volumes, in a thin layer for example, which implies at the present time that it must be heated before packing, and then placed in the can under aseptic conditions. According to BALL (45), a process taking longer than six minutes should not be considered as a high-short process. The various methods of this type which have been proposed, and in some cases adopted commercially, are as follows :

- The H.C.F. process (1-a, 46) which seems to have been the first to be applied commercially to milk based liquid products, such as chocolate milk. For vegetable canning its use has been limited to semi-industrial trials on purees, cream-style corn and similar products, because of the very complicated and costly filling and seaming equipment which is necessary. The letters "H.C.F." stand for Heat - Cool - Fill which describe the technique. It consists of the following stages :

  - sterilisation with saturated steam of the empty cans and covers;
  - sterilisation of the product in thin layers by passing it continuously through a heat exchanger, followed by cooling in a similar machine using cold water. When cooling before filling is not essential to maintain the quality of the product, it is carried out in the container after closing;
  - filling the product into the sterilised containers;
  - seaming of the sterile covers.

All the operations of handling the product and the sterilised containers, filling and closing, are carried out under aseptic conditions in an hermetically sealed chamber containing an atmosphere of steam under a pressure slightly higher than that of the atmosphere (2 - 3 lbs. per square inch). The containers and covers, previously sterilised, are introduced into the filling and closing chamber by a rotary valve. The walls of the chamber are sufficiently strong to withstand a pressure of 20 lbs. per square inch, or more, under which pressure the chamber is sterilised by steam before the equipment is used. With this method, sterilisation of milk chocolate can be carried out with a heat treatment of about one minute at a temperature of 138°-144°C.

- The MARTIN system (47 and 48) is very similar in principle to the H.C.F. System, and consists of the same stages of operation. It differs as follows :

- in the mechanics of the method of filling and seaming. The filler consists of a rectangular tunnel through which the cans peas in single file under a pipe with a longitudinal slit from which the product flows continuously. The same conveyor then carries the cans to the seamer;

- in the method by which the filling and closing equipment is protected from atmospheric contamination. A continuous current of super-heated steam passes from the inside to the outside of the equipment so that no special precautions to obtain an hermetic seal are necessary;

- the method of sterilising the empty cans and covers. This is done by passing the previously washed cans through a drying tunnel and then through a steriliser where they are subjected to super-heated steam or some other hot gas. The covers are also sterilised by super-heated steam applied between the filler and seamer in a specially designed end feed.

In the MARTIN system the sterilisation equipment consists of a pump which draws the product from the hopper and passes it through a heat exchanger consisting of the following three stages :

- a heating section in which the product is rapidly brought to the required temperature;
- a sterilising section where the product is held at the required temperature for the necessary time;
- a cooling section from which the product goes to the filler.

The whole cycle is continuous, synchronised and completely automatic.

This method has only recently been perfected and the first industrial plant was put into use early in 1951 (49) for canning soups. Its capacity is about 250 gallons an hour. The heat treatment of the soup is as follows : it is fed to the heat exchanger at about 80°C and in the first section is brought to 140°-143°C in 3.1/2 seconds. In the second section it is held at this temperature for 9 seconds and cooled in the third section in 14 seconds to 32°C.

In America this line is considered to be one of the outstanding achievements in the Food Industry during the last few years.

- The SMITH-BALL process (1-a) is the most recent variation of the high-short method which has been applied industrially to the treatment of thick liquid foodstuffs containing solid particles, e.g. chop suey. The only point it has in common with the preceding methods is the sterilisation of the product in thin films before canning. The operating technique and mechanical equipment are essentially different. Sterilisation is achieved by heating the product to a temperature of 138°-149°C, and then cooling it to 121°-124°C at which temperature it is introduced into a pressurised room where filling, closing and cooling are carried out by standard equipment.

The steriliser consists of a horizontal stainless steel cylinder inside which are three stainless steel conveyor belts one above the other. They are carried out on a framework and the whole assembly can be withdrawn for cleaning. The foodstuff is spread in a thin film on the top belt and then carried successively along the others, and finally leaves the apparatus through a special cooling valve where its temperature is reduced to that required for filling. The product is then carried into the pressurised room under about 20 lbs. per square inch, in which are placed normal filling and closing machines. Even though the filling and closing room is kept under pressure with filtered air and though the containers and conveyors have been sterilised, and the filling and closing operations are carried out in an atmosphere of steam, or steam and air, this process cannot be considered as being guaranteed strictly aseptic. Contamination by a few spores cannot be excluded in spite of all the precautions taken, but the product is filled at a temperature (121°-124°C) sufficiently high to destroy them. As an additional precaution the filled cans are allowed to stand for a short period before cooling.

Another method of sterilisation similar to the high-short process is a method described by SOGNEFEST and JACKSON (50; 1-a, b) and has been used, particularly for tomato juice, following numerous outbreaks of flat-sour spoilage due to contamination by thermophiles of the type B. thermoacidurans. This process consists in heating the juice rapidly to a temperature of 121° - 122°C by passing it under pressure through a heat exchanger and holding it at this temperature for 0.7 minute. It is then rapidly cooled to 88° - 90°C and filled at this temperature. The filled and closed cans are immediately turned upside down and held in this position for 1 - 3 minutes before cooling, so as to sterilise the headspace and the cover. The sterilising value of this treatment has been shown to be similar to that of a process of 140 minutes at 100°C for A2 cans filled at 77°C. This very well demonstrates the advantages of the high-short process and has been applied on a large scale in America since 1941. It has resulted in almost complete elimination of flat-sour spoilage in tomato juice.

Although agitating processes cannot really be considered as strictly new methods since the idea has been considered for many years for increasing the rate of heat penetration and thus reducing sterilising times in order to retain better the organoleptic and nutritive values of the products, it may be considered as containing some new features because of recent developments and the special equipment which has resulted.

Agitating cooking applied specially to products packed by the "Vacuum Pack" technique, and generally to products with a low heat conductivity was originally carried out in horizontal batch retorts (BERLIN-CHAPMAN system) or in retorts fitted with rotating cages which produced end over end rotation of the cans. Other retorts containing rotating discs which have recently been designed to speed up loading and unloading (BOTT system) also produce a shaking, which, although less severe, still increases the rate of heat penetration in thick products. A new method of agitating cooking in batch equipment has recently been designed and tried out experimentally by CLIFCORN et al. (51). It consists in rotating the cans about an horizontal axis outside and perpendicular to their own axes. The study of this system has shown that this movement in cans containing a liquid phase and with a normal head space produces currents which spread from the centre of the can to the outside. When the speed of rotation is such that the centrifugal force acting on the centre of the can is approximately equal to gravity, the head space gas moves along the walls of the can towards the centre, and thus produces, according to the authors, a rapid diffusion of heat throughout the product. There thus results a marked reduction in sterilising time and the possibility of using high temperatures up to 132°C without harming the product. For canning peas these trials have shown that five minutes at 126°-127°C would be equivalent in sterilising value to a process of 35 minutes at 115° - 116°C under normal conditions. For asparagus, ten minutes at 126° - 127°C is equivalent to 80 minutes at 115° - 116°C. The method

would be particularly useful for products with a slow heat penetration such as purees, strained foods etc.. packed in large cans. It should be noticed that the agitating cooking of sweet corn has introduced in America certain problems through the coagulation of some components of the pack. The difficulty was overcome by adding to the product a small quantity of a special starch produced from certain varieties of corn which had anti-coagulating properties; greater control of the initial consistency of the product and of the sterilising conditions was also necessary. A special method of continuous sterilising with axial rotation was described in a report by BALL (1-a) under the name of "Sterilmatic" and has been perfected for these products.

In the field of new methods there should also be mentioned sterilisation with superimposed air pressure, which has been greatly developed in Scandinavia and Germany because of the use of aluminium cans. Because of their low mechanical strength this method had to be adopted to avoid distortion of the cans by the pressure which developed during sterilising. The system also has several advantages for sterilising glass packs where the closure may be strained or removed by normal sterilising conditions. Various types of retorts specially fitted for this work have been produced; (KVAERNER-BRUG, HAM-JERN and LUBECAWERKE). In these, sterilisation is carried out in water over which air or steam pressure is maintained so that the pressure in the retort is independent of the stérilising temperature. Most of these retorts are fitted with means of re-using the hot water.

Finally, with a view to simplifying the equipment, attempts have been made to sterilise at atmospheric pressure in high boiling point liquids. The idea is not new since the original method of APPERT used either brine or a calcium-chloride solution. In France some tests have been made with chlorinated organic solvents such as perchlorethylene B.P. 121°C (52). The advantages of the method are the simplifying of the equipment needed, the constant boiling point of the liquid which eliminates all temperature controlling mechanism, and the possibility of simultaneously cleaning the cans. However, as might be expected, the method is most useful under normal filling conditions, for very small cans which have sufficient mechanical strength to withstand the internal pressures developed during heating. It appears that the method has been used on a limited scale in certain American factories. BALL (1-a) states that trials with sweet corn were carried out in a continuous apparatus where the cans were agitated intermittently and sprayed by various boiling liquids such as propylene glycol, or certain oils. However, the results were not very successful because of the rapid decomposition and oxidation under heat of the heating liquid. This resulted in corrosion of the tinplate by the decomposition products. The high consumption of heating liquids also makes the operation somewhat costly. BALL considers, however, that such methods could be considered if cans of sufficiently thick tinplate and will specially strengthened ends were used. It would seem, however, that this solution has other objections and could only be considered for cans packed under vacuum.

From the point of view of modification of equipment used for the standard methods of sterilising there should be noted the development of continuous pressure cookers and coolers. The original models have now been perfected and certain recent designs are quite original. Thus, the continuous horizontal ANDERSON-BARNGROVER pressure cooker and cooler of the rotating type has been considerably modified so as to improve its performance, and increase its versatility (1-a). Among these improvements should be noted :

- means for using the same equipment for cans of different sizes;
- means for passing through the same cooker at the same time two different kinds of product, keeping both separate. A special feeding mechanism places cans of each type in alternate compartments of the entry valve, and on leaving the cooker the cans are automatically separated and discharged on to separate conveyors;
- an outlet system in which a pusher arm mounted in the valve makes possible the handling of large cans and avoids damage to the seams.

Experience has shown, however, that the rotation of the cans about their axes which results from the use of the old type continuous cookers, was the cause of cloudy brine in certain vegetables such as peas. New conveying methods have therefore been designed to avoid this rotation of the cans. The most original recent development in continuous cookers is certainly the new continuous pressure cooker by Pierre CARVALLO, PC 100, (1-d, 53) which appears to be the most rational machine so far in existence. The machine consists essentially of three vertical columns each about 10 meters high, in which pre - heating, sterilisation and cooling are carried out respectively. The heating and cooling columns are open to the atmosphere and in them circulate respectively currents of hot and cold water. The sterilisation column which is closed contains steam under pressure. The cans are filled mechanically into perforated tubes hung by their extremities to articulated endless chains. These chains carry the baskets successively through the three columns. Unloading is carried out automatically. The equipment has the following advantages :

- adaptability without adjustment to cans of various shapes and sizes, and even glass jars, because of the tubular baskets;
- the elimination of all mechanical valves for getting the containers into and out of the sterilising section, since the pre-heating and cooling columns serve as hydraulic joints. This gives simplicity, freedom from breakdown, and prevents the introduction of air into the sterilising section;
- the pre-heating of the cans under gradually increasing pressure before sterilising, and their cooling under gradually decreasing pressure afterwards;
- the accuracy and ease of control of the sterilising temperature through control of the height of the water in the pre-heating and cooling columns by means of a simple regulator of the " Genevet " type with an accuracy of ± 2 cm, corresponding to a temperature variation of 1/25°C. The equipment normally runs at a temperature of 120°C and the output under these conditions is 150 A2 1/2 cans per minute.

As far as batch processing is concerned, where standard vertical or horizontal retorts are still generally used for the canning of vegetables, some improvements have also been introduced. Firstly, more and more of them have been equipped with automatic controller recorders which are indispensible for their proper operation, then pressure cooling mechanisms using either air or steam are being more and more used. It is, however, largely in the field of loading and unloading of retort crates where speeding up and mechanisation has taken place, and this has been necessitated by the higher speeds of modern canning lines. For some time, partial solutions have been adopted, consisting in alterations in the construction of the crates to permit of more rapid manual filling (crates with a smaller height, crates with removable sides etc.). Other means have been the use of certain auxiliary equipment permitting the handling of several cans at a time, or various types of special loading devices and of unscramblers for unloading. In France some factories have solved the loading problem by placing the empty crates in a tank of hot water and allowing the cans coming from the

seamer to drop straight into them. The water acts as a cushion to prevent damage and also helps to keep them warm before retorting. In this method, the disadvantage of the loss of retort capacity by haphazard packing of the cans is partly compensated by the increased speed and convenience of the operation.

In the United States the use of a crate with a loose bottom which allows a complete layer of cans to be slid on to it from a loading table has been developed under the name of " Hydromatic " (54). The equipment consists of an hydraulic jack carrying a circular plate. The jack is placed in a pit so that when it is at its lowest point the plate is level with the floor. For loading, the crate is placed over the jack which is then raised so that the loose bottom of the crate is raised to the level of the loading table. The cans come from the seamer on to this table where a number equivalent to one layer of the retort crate are collected. These are then pushed onto the loose bottom of the crate. The jack is then lowered through the height of a can and another perforated plate of the same size as the loose bottom of the crate is placed on top of the cans. This is then level with the loading table and a second layer of cans is pushed onto it. The operation is repeated until the crate is filled. For unloading, the converse takes place. The retort crate is placed on a similar jack and the cans are then raised through the height of one layer, above the level of the crate. An unloading table is placed next to the crate and is joined to a conveyor belt. The layer of cans is then slid onto the unloading table and taken away by the conveyor. The operation is repeated for each layer until the crate is empty.

Another completely automatic system called " Hydromagnetic " (54) has been recently designed for loading and unloading crates of tin cans or glass jars with metal caps. The equipment consists of the following three sections :

- a conveyor to take the containers from the seamer;
- a rotary collecting disc at the end of this conveyor;
- a circular electro-magnet of the same shape as the collecting disc, mounted on a pivot about which it can turn through 145°, and up and down which it can slide.

The containers come from the seamer onto the rotary collecting disc and when this is full the conveyor and disc are automatically stopped. An hydraulic arrangement then moves the electro-magnet so that it comes down onto the containers, picks them up, turns through 145° and lowers them into an empty retort crate. The electro-magnet is then disconnected so as to release the cans and it then returns to its initial position above the collecting disc. The system is so arranged that when the magnet lifts its load of containers the conveyor and collecting disc are automatically restarted. This cycle of operations is repeated until the crate is full. Unloading is carried out by working it in the other direction, and the magnet places the containers which it lifts from the crate onto a large conveyor belt which carries them away. The apparatus is equipped with a counter which automatically controls a stop operating the feed conveyor to the collecting disc so that the number of containers in one retort crate layer can be set in advance.

Finally, the latest development for loading and unloading batch retorts is the BOTT system (55). A special retort crate is used which consists of a series of perforated discs mounted on a central axis which is driven directly by a motor placed on the lid of the retort. An electric hoist enables the motor, lid, and series of discs to be raised or lowered so as each disc may be brought successively to the level of the top of the retort to allow for loading or unloading. The cans coming from the seamer are conveyed by a runway which finishes at the level at the top of the retort, and they are thus run successively onto each disc while it is rotating. Cans may be loaded at speeds of about 300 a minute, and the number of cans run onto each disc is controlled electrically. After the retort is loaded and closed, cooking and cooling are carried out while the cans are being agitated by the rotation of the discs.

After cooling, the above operations are reversed, and the cans discharged at 600 a minute onto a conveyor which takes them to the labelling machine.

Experimental sterilising methods - Electronic radiation - Antibiotics

In the last ten years new prospects have opened up in the preservation of foodstuffs, by the development of the application of electronic energy to the sterilisation of foods. Tests using dielectric heating or high frequency induction heating have so far not given any practical results and seem to have been abandoned for the moment (56 - 57). New developments have, however, appeared as a result of work on non-thermal electronic sterilisation by means of ionising radiations similar to X-rays or cathode rays produced by high potential generators (58). A large amount of research work carried out in America and elsewhere has resulted in considerable progress in this field. A recent paper by PROCTOR and GOLDBLITH (59) shows that among the sterilising ionising radiations (ultra - violet rays, X - rays, cathode rays, by - products of atomic disintegration etc.) only cathode rays (bombardment by very high speed electrons) have any practical possibilities in the food industry. It is also obvious that the problem has not got beyond the experimental stage and that its commercial application is a long way off.

Preservation by means of antibiotics has attracted a certain interest as a result of a paper by ANDERSEN and MICHENER (60) who claimed to have successfully preserved canned vegetables by adding a small quantity of subtilin, (5-20 parts per million), and combining with a short heating of 5-10 minutes at 100°C. However, the claims of these authors appear to have been rather premature since they have not been confirmed by other laboratories. More recent studies (61) carried out under strictly controlled conditions, show that subtilin is able to prevent the growth of the natural bacterial flora responsible for the normal spoilage of vegetables, but that its bacteriostatic power even at a high concentration of about eighty parts per million is not sufficient to provide an adequate margin of safety to preserve canned vegetables by heating at 100°C. It has been shown that such treatment is unsuccessful in destroying the spores of Clostridium botulinum, but it can inhibit certain heat resistant sporing organisms of the "flat-sour" type, particularly Bacilus thermoacidurans in tomato juice containing about 40 parts per million of subtilin. Parallel tests with other antibiotics (gramicidin, methylol-gramidicin, bacitracin and streptomycin) have shown that they have practically no effect on the bacterial flora of canned vegetables.

The usefulness and the interesting possibilities of antibiotics in food preservation have naturally produced many discussions and arguments. The complexities of the bacteriological and physiological aspects of the problem necessitate extreme caution, echoes of which may be found in recent publications by MORSE

(62) and CAMERON and BOHRER (63). Whatever may be the results of future experimental work, the application of antibiotics on a commercial scale in the canning industry does not seem at all likely in the near future.

XII. OTHER TECHNIQUES

Parallel to the progress in the fundamental methods of the canning industry that we have already described, during the last ten years a certain number of special developments have been perfected and introduced to a greater or lesser extent into the industry. Among these should be distinguished specific processes designed to improve the organoleptic qualities of certain special products, and general techniques with the object of improving the hygiene and cleanliness of factories and equipment.

Amongst the specific processes for improving the organoleptic qualities of canned vegetables are :

- the use of calcium salts to harden the texture of peeled tomatoes;
- alkaline treatment for preserving the natural pigments of green vegetables (BLAIR Process).

1. Calcium treatment (66)

Canning processes generally have an unfavourable effect on the texture of vegetables. This is particularly marked for fleshy and watery products, such as tomatoes, and to overcome this it was suggested that a treatment with calcium salts which would react with the pectic substances in the vegetable to produce pectin calcium gels would produce an appreciable firming of the tissues. The theory and practice of the method has been developed by KERTESZ and his co-workers. The treatment consists either in a preliminary immersion of the peeled tomatoes in a 2 % calcium chloride solution for a few minutes, or in adding calcium salts directly to the brine either in dry state or as tablets mixed with common salt. Because of its convenience, this last technique has been most widely adopted by the industy, but immersion before packing seems to be more effective since it reacts with the tissues from the start of the process. Besides the chloride, other pure calcium salts may be used, such as sulphate, citrate, phosphate, etc...

2. Blair process (67 - 68)

From the work of WILLSTATTER on chlorophyl, it is known that the breakdown of the green pigments of vegetables is due to the change of the chlorophyl into pheophytin, which results from the replacement by hydrogen of the magnesium in the porphyrin nucleus. In heat sterilisation the reaction is accelerated by the heat and the slight acidity of green vegetables. It has been found that in an alkaline medium chlorophyl is much more resistant to heat and therefore, both in Europe and in America several alkaline treatments have been suggested for green vegetables so as to protect their natural colour from changes occurring during canning. However, the only process which had any important commercial application is that proposed by BLAIR and others. This process consists in protecting the chlorophyl of peas by maintaining their pH at about 8, and by keeping the destructive action of heating on the green pigments at a minimum by rapid sterilisation at high temperature. The process consists essentially of the following operations :

a)- a preliminary treatment of the peas by soaking them in a sodium carbonate solution (20 grams per litre) so as to bring their pH to 8.8-8.1, followed by washing in water ;

b)- blanching in a lime solution in order to maintain the alkaline reserve in the tissues, to replace the natural calcium extracted during washing and blanching, and to harden the tissues. The peas are blanched in small quantities in fresh brine by means of the rotary bucket blancher mentioned previously (VII, p.4).

c)- washing in cold water and packing with a sugar-salt brine containing a small quantity of magnesium;

d)- rapid sterilisation at 126-127°C followed by quick pressure cooling to about 21°C.

The BLAIR process has no effect on the flavour of the peas and the protection it gives to the colour seems only to be temporary, and necessitates that the cans be stored at a temperature of 12-13°C. Its industrial applications so far have been limited.

As far as improvements in cannery hygiene are concerned - the first thing to note is a general tendency to use a water supply, not only bacteriologically sterile, but even slightly germicidal by means of chlorination (64). The practice of permanent and general chlorination of cannery water supplies has developed in many countries. The object is to reduce the initial bacterial flora of the raw materials, to prevent the formation of slime on equipment and to reduce the danger of contamination of the products during manufacture. A recent Report (65) confirms the advantages in improving the general hygienic conditions in canneries. Water containing one to three parts per million of chlorine seem suitable for all cannery uses, except covering liquids and boiler feed water; for washing purposes water containing 10-25 parts per million is recommended. When general chlorination is not used, more and more use is made of chlorinated cooling water.

In cleaning operation an ever increased tendency should be noted to use jets of detergent solution, wetting agents and more recently bactericidal detergents such as quarternary ammonium compounds.

This review, necessarily brief and incomplete, will however enable an overall idea to be obtained of the technical evolution of the vegetable canning industry during these last few years. In a general way it may be seen that consistent and marked progress has taken place in most sections of it, thanks to the technical and scientific developments which seem likely in the future to become of ever increasing importance.

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VII. DEVELOPMENT IN FRUIT CANNING (1937-1951)

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The operations involved in the canning of fruits are, on the whole, simpler and more straightforward than those concerned with the canning of vegetables. There is not, for instance, the same need for devising objective tests for the quality of the raw material, comparable to those afforded by the tenderometer for peas or the succulometer for sweet corn, neither are conditions generally favourable to the making of tests of this kind. Developments designed to bring about the destruction of bacterial spores - such as improvements in high temperature processing, or the use of antibiotics or of high frequency sterilization - which have provided such a wide scope for studies in vegetable canning, have no counterpart in the canning of fruits. Any discussion on technical problems associated with fruit canning must therefore be somewhat more restricted, as it need not consider, for the moment, the prospect of any fundamental change in the scientific principles on which the canning operations are based. It is true that new technical problems of some complexity have been met with and solved in connexion with the canning of fruit juices but, for the most part, the progress made since 1937 has been chiefly directed towards improvement of design of plant and equipment, and increase in mechanization and speed of operation of canning lines. Real progress, as regards quality and quantity of output, has been made in several countries and it might be helpful to start this brief survey with a reference to such statistics as are available, in order to note the extent and trend of these developments.

I. PRODUCTION OF CANNED FRUITS

Canners in most parts of the world have had to contend with abnormal conditions during the past six years. In many countries the restrictions imposed during the war, were only removed slowly, if at all, and in some cases the acute shortage of raw materials - chiefly cans and sugar - still persists. Currency changes have profoundly affected exports and imports of canned goods, and some countries, by restricting imports, have encouraged production for the home market. In spite of these difficulties output of canned fruits in most countries has increased during the past fourteen years. A comparison of production figures for canned fruits and fruit juices in the U.S.A. for the two four-year periods 1936-39 and 1947-50 shows an increase of nearly 100 per cent, the present annual output amounting to about 2 1/4 million tons. The most outstanding development has been in frozen concentrated orange juice in cans, but big increases in output are recorded for all the main fruit juices - orange, grapefruit, pineapple, blended orange and grapefruit, and apple. Other increases have been in peaches, cocktail fruit, apple sauce and cranberry sauce. An appreciable fall in the output of canned berry fruits (strawberries, loganberries, raspberries and blackberries) is due to the tendency to preserve these fruits by quick freezing.

None of the other countries from which statistics are available can show an output of canned fruits (excluding jams) much more than four per cent that of the United States. The United Kingdom, Australia and

France, have each an annual output between 70,000 and 90,000 tons. The production of canned fruit in the United Kingdom has expanded about 150 per cent since the immediate pre-war years, about half the total pack being plums and damsons. At the end of the war there was a great shortage of soft fruits in England and Scotland, and for several years rhubarb in syrup was an important pack, but the recent great increase in acreage of soft fruits has resulted in a larger quantity of strawberries and raspberries being packed. The quantity of fruit canned in Australia shows little increase on that of pre-war years, excepting pineapples; a tropical fruit salad is now packed in some Australian canneries. In France the proportion of fruits packed in syrup to the total output is only about one-sixth, but is rising; water packs and a substantial pack of apple sauce constitute the remainder. In South Africa fruit canning has expanded almost threefold since 1939, peaches, pears and apricots constituting about 40 per cent of the total output of 35,000 tons; developments in pineapple canning are reported and experiments on canning granadilla juice are in progress. The output of canned fruits in Canada is about the same as that in South Africa.

Of the smaller countries which have made conspicuous progress in post-war years mention must first be made of Israel, where the annual output of concentrated orange juice and orange slices is now about 5,000 tons. About 3,000 tons of the concentrated orange juice is supplied, to a strict specification and at a guaranteed vitamin C content, to the United Kingdom for distribution to Maternity and Child Welfare Centres. Morocco has an annual output in the region of 10,000 tons, consisting mainly of orange, apricots, and tomato products. Developments are also reported from Tunisia and Algeria.

II. IMPROVEMENTS IN RAW FRUITS

In starting to can any particular fruit one of the first considerations must be to select the most suitable varieties for the purpose. This can be done by making a comprehensive series of tests of locally produced varieties, or by importing and growing ones which have given good results elsewhere. At a later stage conscious efforts may be made to produce new varieties with certain desirable characteristics - such as very early or very late ripening, or the possession of qualities which make the fruit highly acceptable to growers as well as to canners. Important progress in extending the season for peach canning by as much as 46 days on either side of the period for the standard variety is reported from South Africa where work is also in progress on improving the canning characteristics of berry fruits and guavas. Considerable work on the selection and improvement of varieties is also reported from Australia. About eight years ago an outstanding series of experiments was undertaken at the University of Cambridge Horticultural Research Station in which more than 1,500 new strawberry varieties were raised. Canning and quick freezing tests were made on a small selection of the most promising but, while some varieties were good for canning or for quick freezing, none was found to be of the highest quality for all purposes - e.g. fresh market, canning, quick freezing and jam making. A new strawberry variety introduced by the Scottish Department of Agriculture, and known as Auchincruive Climax, has proved to be satisfactory for all purposes and, in addition, to be of vigorous growth and a good cropper. The selection of varieties of peaches and pears according to the length of period in which they can be held in cold store or gas store before canning has been the subject of investigations made in Australia. Work on the testing of grapefruit and orange varieties is reported from Israel.

III. CANNING PLANT AND TECHNIQUES

In many countries the canning plant and techniques which were in general use before the war are still common practice, with only minor modifications designed to reduce hard labour and increase the speed of operation, but considerable changes have occurred elsewhere, and particularly in the United States.

1. Handling of raw fruit

Developments have taken place in the unloading and handling of lug boxes of peaches, pears and apricots, practically the whole of the operations involved being mechanized in many of the larger factories.

2. Size grading of fruits

The increasing use of automatic peelers for pears has called for greater attention to size grading in order to reduce waste. In some American canneries pears are separated into 21 grades - seven different diameters (graded automatically), and three different lengths (graded by hand).

3. Pitting

The pitting of peaches and apricots is now largely automatic, the most modern machines splitting and removing the pits while the fruit is being cut in half.

4. Peeling

Lye peeling of peaches and apricots is common practice in the United States, France, Australia and others countries. Tomatoes are also peeled in this way. A common modification of the simple lye peeling procedure is to pass the fruit through the lye bath containing a suitable detergent, and then, to expose the

ruit to superheated steam at 300°F. Plums, peaches, pears, apricots, apples and tomatoes have been peeled uccessfully on a commercial scale in the United Kingdom using a thermo - peeler consisting of an electric urnace operating at temperatures up to 1,000°C. the fruit taking 10 - 30 seconds to pass through, and the corched skins being removed subsequently under pressure sprays.

5. Filling

No striking advances appear to have been made towards high-speed automatic filling of cans with ruit. Peaches, pears and most berry fruits are still filled by hand.

6. Syruping

The chief advances in syruping are an increase in rate of operation and the use of vacuum syruping n conjunction with steam flow or vacuum closing.

7. Exhausting

The most striking change in fruit canning practice during the past few years has been the replacement f the exhaust box by a vacuum syruper and steam-flow. This disappearance of the exhaust box is widespread n the United States, and has also taken place in some canneries in Australia; it is not reported from other ountries.

8. Closing

The injection of jets of low pressure steam into cans while they are inside the seaming head of the losing machine produces a high vacuum when the cans are cold. This procedure has been used on a large scale n the United States for several years. Although experiments on steam-flow have also been made in the United Kingdom the general adoption of this method in place of heat exhausting has not yet taken place in that ountry.

9. Processing

The only modification reported in connexion with the processing of fruits, is in the use of pressure ookers for peaches and pears in some American canneries. New designs for cookers are reported from France.

10. Speed of operation

One of the most obvious advantages in recent years has been in the rate of operation of canning lines. In some American canneries these are now running at speeds of 160-200 cans a minute for sizes up to No. 2 1/2. In most cases these high speeds are on lines fitted with vacuum syrupers and steam-flow.

IV. SPECIAL PRODUCTS

1. Citrus fruit juices

Mention must be made of the great developments which have taken place since 1946 in the canning of fruit juices - particularly frozen concentrated citrus juices. Various methods of concentration are used but, in general, the procedure is to pass about 80 per cent of the juice through a fine screen and concentrate it in a low-temperature high-vacuum evaporator to about 60 per cent solids. The remainder of the juice (which contains the full volatile constituents of the fruit) is then added to produce a product of 42 per cent soluble solids. This is cooled to below 25°F, filled into cans, and stored at -10°F. Improvements in the design of juice extractors are reported from Israel.

2. Tomato juice

Presterilization of tomato juice by passing it rapidly, and under conditions of considerable turbulence, through a heat exchanger at a temperature of 250-280°F is now used as an alternative to long low-temperature sterilization in cans. A holding time of 40-45 seconds at 250°F is sufficient to destroy the spores

of flat sour organism Bacillus thermoacidurans, and after this treatment of the juice the cans are filled under sterile conditions at 190°F and held three minutes at that temperature before cooling.

3. Jams and jellies

Details of progress made in the canning of jams and jellies during the past fourteen years have not been given from any country other than the United Kingdom, where the chief advances reported are in the mechanization of jam production units. A machine is now used for the preparation of oranges for marmalade which is said to result in a labour reduction of 90 per cent compared to hand peeling. Improved stoning machines for cherries and plums are also now available, and compressed air systems are used for moving fruit pulps from one section of the factory to another. Vacuum boiling pans are little used in the United Kingdom, but super-rapid boiling pans are installed which finish a boil of 100-150 lb. of jam in 5-6 minutes.

V. QUALITY CONTROL AND STANDARDS

It is gratifying to note that considerable efforts are being made to improve the quality of canned fruits. The U.S. standards are well known, but other countries, particularly those with a developing export trade, have made regulations requiring that all canned fruit and vegetables for export are examined for quality by government inspectors; in some cases these inspectors are stationed permanently in the canneries. The regulations sponsored by the South African Bureau of Standards are a good example of a modern scheme for quality control, and others are in force in Canada and Australia. In the United Kingdom a voluntary scheme for quality control under the National Mark was operated until 1939, when it was withdrawn on the outbreak of war. Regulations governing minimum filled weights and syrup densities were introduced during the war and are still in force, but there are no official standards of quality although there is a voluntary inspection scheme under which all canners submit cans to the Campden Research Station for examination and classification into grades according to quality.

VI. RESEARCH

A survey of this sort would not be complete without some reference to the scientific and technical research institutes which are now established in most countries where fruit canning is an important activity. The work of the long established research stations in the United States, England and France is well known, but special mention must be made of the developments which have taken place in Australia in the laboratories of the Division of Food Preservation and Transport of the Commonwealth Scientific and Industrial Research Organization, and in the Horticultural Research Stations associated with the State Departments of Agriculture. In South Africa the testing of new varieties has been actively undertaken at the Western Province Research Station at Stellenbosch. In Israel scientific and technical research is in progress at the Central Research Laboratory, of the Citrus Concentrates Producers Association, while one of the most recent additions to the list of research laboratories is the Swedish Research Institute for Food Preservation, which is located at Gothenburg. The activities of all these bodies, working in the interest of canners, constitute a hopeful sign for the prosperity of the fruit canning industry throughout the world.

VII. CONCLUSIONS

To sum up - it may be stated that the changes which have taken place during the past fourteen years have been mainly in the direction of increased mechanization, the greater use of stainless steel in plant and equipment, and a considerable rise in the rate of throughout on the canning lines. The rapid development of frozen concentrated citrus juices in cans must be mentioned, and also one striking modification in the fruit canning operations - namely, the use of vacuum syruping and steam flow closure. In some countries many of the canneries have coupled quick freezing with canning, and have thus forestalled any tendency for these two forms of fruit preservation to develop in opposition. Given reasonable supplies of raw materials and normal progress in the technical field it looks as if the fruit canning industry can confidently expect still greater developments in the years that lie ahead.

VIII. DEVELOPMENTS IN THE CANNING INDUSTRY IN ALGERIA BETWEEN 1938 AND 1950

by F. NEAU

Établissements J. J. Carnaud et Forges de Basse-Indre (Algeria)

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GENERAL CONSIDERATIONS

Until 1939, apart from the fish canning industry which had reached a fair size, only a few factories were equipped for general canning and frequently this was only a secondary activity for them.

Since then the production of the Algerian Canning Industry has been practically quadrupled between 1938 and 1950. This great increase stimulated initially by the war has been able to continue and develop since 1946 because of its gradual adaptation to the requirements of true industrial activity and because it supplies Algeria's need to absorb the surplus of its own production.

We will consider successively the development of the different branches of the Algerian canning industry since 1938 i.e. fish canning, fruit and vegetable canning, fruit juice canning, meat canning and miscellaneous products.

I. FISH CANNING

Between 1938 and 1950 the number of sardine canneries increased from 28 to 48 and that of the brining stations from about 80 to 130, but it should be remembered, however, that most of the sardine canneries are connected with a brining station. Originally the sardine canneries were almost all put up by fishermen and the methods of production were somewhat primitive. Even in 1950 they still retain some of the characteristics of a family business, and few large firms as yet have factories for the manufacture of fish products. In many cases the businesses are still run by the descendants of the original fishermen. Most of them wish to modernise their equipment and increase their production but they lack capital to carry this out fully.

However, although in 1938 half the factories did not use steam (the fish being fried in pans heated by fires and the cans sterilised in boiling water) in 1951 the buildings have been enlarged and all the canneries are better equipped. They now cook in steam or have automatic fryers and the drying tunnels and retorts are all steam heated.

The very considerable progress made in the manufacture of canned sardines has lead a certain number of the Algerian canners to enquire more fully into modern methods of fish treatment and there is little doubt that in the near future a new stage in the modernisation of Algerian factories will be reached.

It is estimated that the capacity of the Algerian fish canning factories which was of the order of 200,000 cases (100 1/4 Club 30) in 1938 was over 800,000 cases in 1951. However, owing to shortage of fish, and since 1950 shortage of tinplate, never more than about 50 % of this maximum capacity has been used.

The fish canned on the Algerian coast are sardines, sardinella, anchovies and tunny, and to a much smaller extent shrimps.

I. Sardines (Clupea pilchardus) and sardinella (Sardinella aurita)

One of the principal characteristics of the fishing industry in Algeria is its primitive nature and it has not changed much between 1938 and 1950. The fishers use mediterranean boats called " Lamparts " and seine nets canned " Lamparos ". Mostly fishing is done at night, the fish being attracted towards the boats by powerful lights, which give the boats their name. During certain favourable periods the fishermen use gill nets and the fish caught in them are called " Meshed Fish ".

They never use a bait which appears not to be very effective in Algerian waters.

Since 1943 ring net fishing has been tried out by one canner but has had to be given up because of the hostility of the fishermen. In 1949/1950 new trials were carried out with a ring net at three different places and these were quite conclusive. They have, however, caused great discontent among the fishermen who have persuaded the government to ban the use of the ring net in Algerian waters.

It cannot be doubted that sooner or later this position will have to be altered and the fish canning industry in Algeria will then have received a new lease of life, thanks to the large and regular supplies of good quality fish which will be available to it. Only an increase in the number of boats and the use or a few larger ones of a size somewhere between the "Lamparos" and a standard trawler have allowed of an increase in fishing and hence of the canning industry. From 350 ships in 1938 the Algerian fishing fleet increased to 600 ships in 1950.

The quantity of fish handled for canning was of the order of 9,000 tons in 1938 and increased to an average of 20,000 tons for 1949 and 1950. Sardines represent about 80% of the fish but this varies according to the region and from one year to another.

2. Anchovies (Engraulis encrassicholus)

Landings of anchovies in 1950 have been slightly more than those of 1938. 1,750 tons have been salted in 1950 about half of which has been exported in wooden barrels, (called "Bordelaises" and "Siciliennes").

3. Tunny (Thunnus thynnus) and bonito (Euthynnus pelamis)

The quantity of tunny and bonito caught off the algerian coast is relatively small and very irregular. Apart from two "madragues", which have never been properly used no industrial fishing has been undertaken. A new trial of the "madrague" will be carried out in the 1951 season in the region of Cap de Fer to the North East of Philippeville.

4. Crustaceans

Numerous trial packs of crustaceans, principally shrimps, have been attempted by various Algerian canners but only three have been able to obtain a quality suitable for export, particularly to England, where about three to five thousand cases have been sent.

Fishing for lobsters and shrimps remained about constant between 1938 and 1950 and reached an average figure of about 1,000 tons per year. However, as for the blue fishes the methods of fishing have not been modernised.

II. FRUIT AND VEGETABLE CANNING

We have intentionally grouped together these two activities although they are essentially different, since most Algerian canners are equipped to handle fruit and vegetables simultaneously. Before 1940 Algeria only produced very irregular and small quantities of fruit pulps. According to requirements these were usually imported from the Balearic Islands or the region of Murcia.

The industry, however, produced about 500 tons of jam the balance necessary for local requirements being supplied by the importation of about an equal amount from France.

The production of tomato concentrates was about 500 tons but the development of this branch was hindered by strong foreing competition particularly from Italy.

The canning of vegetables was practically non - existent (about 50 tons per year). Then came the events of 1940 which suddenly deprived Algeria of all commercial supplies from the outside world. Partly isolated from France she only received a small part of the food supplies to which she had been accustomed. She was at the same time deprived of the outlets usually available to the products of her own soil.

The results of this double effect obliged the Administration to encourage the development in Algeria of an organised canning industry. In 1941, The Syndicat Professionnel des Conserveurs de Produits Agricoles was established and the first standards were fixed in June 1942 by the Office Algerien d'Action Economique et Touristique (OFALAC) to whom was given authority to ensure their observance. This was the birth of the real Algerian Fruit and Vegetable Canning Industry.

At the end of hostilities, the consequences of which were felt until about 1948, certain alterations were made in the industry which found its activities decreasing since they were badly adapted to a normal Algerian economy.

Although in 1938 there were seven canneries in Algeria with a maximum of two thousand tons, in 1950 there were 18 canneries with a total capacity of about thirty five thousand tons. The number of factories has reached about 30 in 1945, but many of these developed during the war and were of a speculative nature. They were only precariously established, and their disappearance was only to be expected.

However, very interesting results were obtained and several well equipped factories survived and new ones were built. The administration, French farmers and the local population, has realised the need for a canning industry in an essentially agricultural country like Algeria, and a number of foreign importers had become aware of the possibilities of the local canneries. We shall see the consequences of this when considering the products and the equipment of the Algerian industry.

I. Fruits

The principal fruits handled are apricots, oranges, cherries, quinces, figs, sweet potatoes, dates and olives. These fruits are made into such things as pulps, pastes, jams and fruit in syrup. We will deal in the next chapter with the question of fruit juices which seems to us to deserve separate treatment.

a) Apricots

The development of the orchards of which about 5,000 acres were planted with apricot trees makes it likely that there will be a marked increase in apricot products in the years to come.

Three factories have equipment for the production of halves either in water or syrup. The manufacturing processes consists of :

1) washer, and continuous sorting table;
2) stoning table;
3) syruper and exhauster.

b) Oranges

Because of the importance of its ever increasing production (270,000 tons in 1950) Algeria has found itself able to take a major place in the market for pulps, jams and oranges in syrup. Four canners have modern equipment for the production of course of cut marmelade and only the high price of sugar on the Algerian market, even when intended for re-export, has prevented Algeria from taking its proper place.

c) Figs

A special variety, the "Kadota" fig, grown in the region of Tenes at the junction of the departments of Algiers and Oran has all the desirable characteristics for the manufacture of jam and figs in syrup. These excellent products have found outlets in England and the Scandinavian countries which seem likely to increase considerably. A great effort to equip itself with the latest plant has been made by a factory specially designed for the packing of these fruits.

d) Sweet potatoes

These are used for an Algerian speciality product somewhat similar to chestnut puree, but whose price is much smaller. It is regrettable that this too little known product has not yet been able to find, in France especially, the outlets which it merits.

e) Dates

Since 1938 numerous attempts to can whole dates have been made. These attempts, whether they were carried out by packing in an inert gas, or by sterilising the product, have always come up against the special marketing conditions for dates which are traditionally prepared and packed in the region of Marseilles, and exported in small wooden boxes. However, the first commercial trials carried out by an Algerian canner in 1950 enabled him to export to South America nearly 200 tons of dates packed in metal containers. It should be noted that Algeria has almost the monopoly of the "Deglet-Nour" date (20,000 tons approximately, out of a total production in the Sahara of 25,000 tons) which is much sought after in the world's markets and up to now has not been grown in other parts of the world in spite of various trials carried out especially in California.

f) Green and black olives

Large quantities were produced for the first time at the end of 1950 and have enabled an excellent product to be marketed, of which Algeria looks forward to a considerable development in the years to come.

Up to now only one Algerian canner has modern equipment for the production of black olives packed in metal cans and sterilised. Most exports of Algerian olives have been raw in brine, in either metal drums of ten or twenty kilos or in wooden barrels.

2. Vegetables

Amongst canned vegetables should be mentioned peas, green beans, carrots, artichokes, celery, and above all tomatoes.

a) Peas

We will only mention these as a reminder in this paper since they have only been produced up to now in extremely small quantities although Algeria can produce large quantities of good standard quality. The largest production was about 35,000 cases (24 1/1 cans - 850 ml each) reached in 1949.

Since 1946 four factories have been fitted with modern equipment for packing peas and have viners, podders and graders. One also has a brine grader.

b) Green beans and celery

Actually canned green beans and celery should be capable of much greater production because of the quality of the Algerian raw material. Up till now only very small amounts have been handled, the Algerian factories not being equipped for large scale production. However, in 1949/1950 a factory near Oran obtained some good equipment, notably two snibbers and two automatic graders for the canning of green beans.

c) Carrots

Several thousand cases of carrots in brine were packed in 1950 for the English market, but these packs only represent a very small part of the 20,000 tons exported as the fresh vegetable.

d) Artichokes

Artichokes grow well in Algetian, and their production could be considerably increased. Production in Algeria is about 20,000 tons per year almost all exported fresh. Only three canners pack artichoke hearts. One of them, originating from Lyons, and who packs the same sort of products in France thinks that : " The artichoke or Brittany is more delicate, but breaks up more on cooking. The Antibes artichoke is almost the same but it is very dear. The local artichoke has the advantage of a good average quality and, in season, of very cheap price ".

e) Tomatoes

The meet Italian competition and to maintain the advantage gained during the war several Algerian canners have attempted methodical research to try and acclimatise on Algerian soil various qualities of tomatoes. It is thus that after, the San Marzano, the Chatham, and the Marglobe have been grown in Algeria. Their efforts now seem to have been successful since after several years certain varieties, notably the Chatham, have proved perfectly satisfactory and are growing excellently in Algeria where the production of plants has increased with this acclimatisation.

This variety whose plants are very bushy gives a good yield of uniform fruit which can stand a large amount of sunlight.

The opinion of certain knowledgeable manufacturers the whole tomato is likely to take a greater and greater place on the market and even to replace to a certain extent extracts and concentrates. The quality will be greatly superior and the price roughly the same all things being considered.

The factories are well equipped and at least two of them compare favourably with the largest factories in France.

III. FRUIT JUICES

The juices of the following fruits are packed :

orange, tangerine, grapefruit, lemon, tomato, muscatel grapes.

At the moment 80 % of the production is represented by orange juice.

For some time certain large producers of Algerian citrus fruits have been interested in juice production but it was only in 1938 when a flash-pasteuriser designed by MM. CHEFTEL and ROZE, and built by Messrs. JOUAN was installed at Boufarik that for the first time orange and grapefruit juice could be made in Algeria. The war of 1939 to 1945 interrupted these beginnings, but in 1947, still at Boufarik, production of juice with a new flash-pasteuriser with a capacity of one thousand litres an hour was begun again.

In 1945 a factory specialising in the manufacture of juice was put up near Algiers with a Corblin flash-pasteuriser which had a capacity of one thousand litres per hour. Two other factories whose principal products were jam and pulps also began juice production but on a very much smaller scale.

The idea of fruit juice production in Algeria was thus well started and a number of people began to be interested, however, the manufacturers mentioned above, were not able to obtain successful result from their efforts because during this period the fresh fruit was making very high prices which resulted in an excessive cost for canned juice.

At the end of 1950 several very active businessmen established a new company for the manufacture of fruit juice. They managed to interest a certain number of the fruit growers in their project and were able to obtain very modern equipment, in particular two "Pipkin" extractors from the Food Machinery Corporation. Their factory is comparable with American factories and has a continuous flash - pasteuriser with Taylor automatic controls.

For its first season this company will benefit from the fairly low prices for fruit resulting from a very good harvest. Certain large markets have also been established.

After having manufactured 780,000 litres in 1950/51 they propose to double their production in 1951/1952. The rational treatment of by-products will enable more economical production to take place next year.

The total Algerian production of citrus fruit juice was approximately 900,000 litres during 1950/1951.

The production of 300,000 litres of tomato juice is forecast during the summer of 1951.

IV. MEAT AND MISCELLANEOUS PRODUCTS

1. Meats

At the end of the war the authorities gave an order for the production of an appreciable quantity of canned beef for the army. A factory tendered for this and produced a good quality product, but no plant has specialised in this work since up till then it was only of an intermittent nature. The results obtained showed the possibilities of local production and three factories are now equipped for the production of canned beef. On the other hand four new factories are being built for the production of canned pork products, two are in production and two others in course of construction. One of them, situated in the heart of the pork producing region has very modern equipment which enables it to handle 50 pigs and 250 sheep per day.

These factories are capable of handling, in particular, hams and meat pastes (about 1,000 tons per annum). The cattle, produced locally, give a product of a reasonable quality and have the advantage of being cheap.

2. Spaghetti in tomato sauce

Trials were made for manufacturing this product, which is much in demand on the English market. Algeria is a large producer of hard wheat and of tomatoes and appears to be particularly suitable for making it. However, no market has been obtained to date although two factories at least are capable of producing this product.

V. CONCLUSION

As we said in the beginning the production of canned food in Algeria has quadrupled between 1938 and 1950. The equipment of the factories has markedly improved but their remains much to be done.

The reasons which have prevented the Algerian canning industry from developing more rapidly are, apart from temporary difficulties, due to local circumstances :

a) insufficient capital of most of the companies;

b) the lack of skilled technicians.

IX. TECHNOLOGICAL AND ECONOMIC ADVANCES IN THE AUSTRALIAN CANNING INDUSTRY SINCE 1938

by C. E. NORTON

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Since 1938, Australia's canning industry has passed through a stage of technical and economic development which has been surpassed by few other countries during this period.

The comparative growth in volume of production has varied widely between different classes of canned products. For example, the pack of canned fish has increased 18-fold since 1938, while the total pack of the major canned fruits has remained almost stationary. The pack of canned meats has increased by approximately four times, while that of canned vegetables has been multiplied about five times. These data of increased volume of pack, however, do not tell the entire story of the development toward a more integrated canning industry.

I. STAGES OF DEVELOPMENT

For the purpose of orientation, the period within the scope of this report may be divided into three phases :

1. the phase of steady growth which prevailed in the Australian canning industry immediately prior to World War II;

2. the phase which began with the entry of Australia into the War, with the immediate requirement by its military forces for canned rations, many units of which were not ordinary items of peacetime civilian consumption. The intensive part of this second phase began with the opening of hostilities in the Pacific, when in early 1942 Australia was called upon to act as a supply base for the Allied Forces, to fulfill many of the varied, large-scale ration requirements of the Netherlands, Free French, British and American military forces, in addition to those of its own military services;

3. the postwar phase of adjustment. In some sections of the canning industry, this phase presented the problem of utilizing, to the greatest extent possible in peacetime, the production capacity which had been built up during the war. In some instances, the "sterling currency" status of Australia made possible the supply of canned foods to markets at home and abroad, now largely closed to the former suppliers located in " hard currency " areas. However, the industry has been very much aware of its own vulnerability to losing its present advantage in these markets by possible changes in import regulations or in alterations of existing monetary rates of exchange; consequently, it has been realized that these markets can be gained and held only by promoting efficiency in canning factory operation and maintaining a high standard of quality of the canned products.

To accomplish the aims noted above, there has been intensified effort along the following lines :

a. increased technical service to the canning industry:
   (1) in improvement of raw products used;
   (2) in the improvement of processing methods;

b. setting up of additional standards of quality;

c. installation of improved high-speed canning machinery;

d. improvement of can supply.

II. TECHNICAL ASSISTANCE AVAILABLE TO THE CANNING INDUSTRY

In the general program of improvement of the supply of the raw materials to canneries, several agencies of the Commonwealth (Australian Federal Government), various state governments, private agricultural producer's associations, and food processing companies have made outstanding contributions. Among these are the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O., known as the Council for Scientific and Industrial Research (C.S.I.R.) until 19 May 1949), the Commonwealth Department of Commerce and Agriculture, the State Departments of Agriculture with their Horticultural Research Stations, the State Departments of Fisheries and Game, the canning crops field supervisors, progressive individual growers interested in crop improvement, and vegetable seed companies, who have made Australia largely independent of overseas supplies.

In enumerating the various agencies which have contributed to improvement of processing methods in the Australian canning industry, the Division of Food Preservation and Transport of the C.S.I.R.O. must be placed foremost. Established as a section of the C.S.I.R. in 1932 with Dr. J.R. VICKERY as its Officer-in-charge, its status was raised to that of a Division in 1940 with Dr. VICKERY as Chief, as he remains to this date. As early as 1936, the section (1) was concerned with canning problems, particularly in connection with fruit utilization. With the outbreak of war in 1939, the C.S.I.R. possessed a staff which was close enough to the canning industry to be of considerable assistance when the rapid expansion of canning operations brought on new problems.

When large - scale canned ration procurement was begun in Australia by the U.S.A. military services in late 1942, the U.S. Army Procurement Division included a technical group in which was a number of food technologists with a wide experience in the U.S. canning industry; in addition to canning technologists, this group including specialists in large-scale production of canning crops, in can-making, and in can closing.

Commonwealth Food Control, a wartime agency which coordinated production and allocation of military and civilian food supplies as a unit of the Commonwealth Department of Commerce and Agriculture, set up a Technological Section, equipped with food examination laboratories and trained canning technologists. Good coordination of all of the above-named personnel was accomplished, as well as good cooperation with the resident veterinary inspectors of the Department of Commerce and Agriculture, who at all times maintain surveillance on canning of foods for export. From these wartime conditions of mutual exchange of technical information and necessity of improving efficiency of cannery operation, the industry emerged from the war both more "technical-minded" and streamlined in factory layout. Unfortunately in 1947, the Technological Section of Food Control was disbanded, both as to staff and laboratories, rather than being retained as a valuable service section for the food inspection activities of the Department of Commerce and Agriculture. Fortunately, many staff members of the disbanded section readily found positions in the canning industry, since the canner's wartime experience in the value of technical assistance led to the setting up of Quality Control programs, within the limits of availability of trained canning technologists.

In the postwar period, the C.S.I.R.O. Division of Food Preservation has carried on technical service work for canners in addition to research on canning problems. In New South Wales, the location of the C.S.I.R.O. Food Preservation Central Laboratory, the C.S.I.R.O. maintains a standing committee for coordination of research on fruit and vegetable processing. At the second annual Australian Canning Convention in 1950, a more comprehensive advisory committee was suggested to cater for the canning industry in all Australian states; further consideration may be given to this matter at the 1951 convention.

Several companies supplying canning machinery, cans, etc., have installed laboratories, one of whose functions is to render technical service on canning problems.

Since the war, Food Technology courses have been initiated at the N.S.W. University of Technology

NOTA : Figures between ( ) refer to Bibliography, p. IX-11.

(2), as well as at the Hawkesbury Agricultural College, N.S.W. (3). These courses, plus those planned for the near future in other states, will furnish the canning industry with needed technically-trained personnel for management, production engineering, and quality control staff.

III. RESEARCH IN THE CANNING OF FRUITS AND FRUIT PRODUCTS

The fruit-growing areas supplying canners have been represented by outstanding orchardists who have been interested in fruit variety improvement, both by local varietal selections and by introduction of promising varieties from overseas. In the late 1930's, this early work was supplemented by an intensive program of varietal improvement by the State Departments of Agriculture, centering in their Horticultural Research Stations, particularly in the States of Victoria (4) and New South Wales (5). This work is now beginning to yield promising results toward the aim of eliminating many of the disabilities of the fruit varieties now being grown for canning.

1. Peaches

The clingstone varieties of peaches represent the greater part of the canned production; however, the canning of freestone peaches (6) is not being entirely neglected. The clingstone varieties grown in the States of New South Wales, Victoria, and South Australia are represented mainly by the Phillips, Golden Queen, and Pullar varieties. Among varieties of minor importance are Levis, Palora, Sims and Gaume.

The canneries handling the present varieties are handicapped by the concentrated delivery of cling peaches so that, in some cases, 50 percent of the crop is delivered to the canneries in less than three weeks. This situation necessitates holding some of the tonnage in cold storage to prolong the season. Studies have been conducted in an effort to prolong the period during which the peaches can be held in refrigerated storage yet be properly ripened for canning after being removed from cold storage. For example, the Golden Queen variety held at 32°F normally cannot be so stored for longer than 2 1/2 weeks and yet ripen normally. Studies have shown that if peaches of this variety are cooled prompty after harvesting (7) and held at 42°F, the length of storage can be prolonged to approximately 4 1/2 weeks.

Some of the present varieties of clingstone peaches have retained their popularity with growers because of reliability of yield from year to year. However, some varieties do not possess as high canning quality as could be desired and have other disabilities such as large or irregular shaped pits to which the high-speed pitting equipment is not easily adapted.

The varietal selections which have resulted from the horticultural research work which was started in the late 1930's has yielded some promising varieties which possess high canning quality, as well as small pits which can be handled easily. The most outstanding of these varieties is the Wight (5) which has its parentage in the South African Transvaal Yellow Variety. In New South Wales, the greater part of the new planting is of this variety.

2. Apricots

The apricot acreage for canning is largely of the Australian variety of Trevatt, while the minor varieties are Moorpark, Blenheim and Tilton. The Trevatt variety appears to be an excellent grower's selection in that it is easy to handle and is a dependable bearer. In some regions, however, it has been found somewhat deficient in flavor. The Moorpark variety is popular from the flavor standpoint but in some areas tends to ripen unevenly. Studies have been carried on to correct this deficiency. It has been found (7) that in cases in which the side of the apricot exposed to the sun ripens far in advance of the unexposed side, it is possible to harvest the apricots at the time the fruit develops the first sign of yellow to place the fruit in a ripening room at 65°F, and to ripen evenly to excellent canning maturity in six days. This fruit yields a product of good texture, flavor and juiciness. This practice, however, cannot be followed safely unless the brown rot fungus is well under control.

3. Pears

The standard variety for canning in Australia is the Williams Bon Chretien, which is synonymous with the Bartlett variety used for canning in other parts of the world. Research is being carried on in some growing areas (4) (5) to determine the reason for irregularities of fruit shape, which sometimes result in excess waste during preparation. Studies are also being carried on to learn the causes of variation in flavor from one growing area to another.

Since many of the fruit canneries are highly seasonal in operation, it is sometimes necessary to hold the pears in cold storage for sufficient time to allow the peach canning to be completed. Consequently, investigations have been carried out in an effort to prolong the effective storage life of the pears for canning. The Williams variety ordinarily can be stored for three months at 29-31°F. It has been found (7), however, that if the CO_2 gas which is generated by the natural respiration of the pears in storage is allowed to accumulate in the cold storage room up to 5 percent of the atmosphere, and regulated at that content, the effective storage period can be prolonged to five months instead of the usual three.

4. Composite Fruits

Although prior to the war, a small quantity of canned fruits for salad and fruit cocktail was packed, this was discontinued during the war years. In its place, a " two-fruits " pack (cubed or diced peaches and pears) was adopted, and this has made up the "composite fruits" pack since that time. See Table No. I. In the 1950-51 season, however, production began on a limited quantity of fruit cocktail.

TABLE I

AUSTRALIAN PRODUCTION OF CANNED FRUITS AND FRUIT PRODUCTS - UNIT : CASES OF 24 No. 2 1/2 CANS

CANNED FRUIT	Average 1935-1939	1944	1945	1946	1947	1948	1949	1950
Apricots	288,698	327,946	138,631	233,760	272,275	396,801	452,801	646,739
Peaches	1,434,608	1,344,248	1,292,670	1,020,817	1,474,100	1,650,322	1,208,596	1,363,385
Pears	709,691	602,200	614,566	641,083	817,567	879,920	1,008,598	999,759
Composite Fruits ...	N. A.	33,520	33,088	29,050	61,471	25,082	37,791	47,972
Pineapple	277,454	110,798	117,237	163,620	214,032	425,330	504,489	N. A.
Berry Fruits ..	N. A.	N. A.	N. A.	N. A.	N. A.	36,000	50,000	N. A.
Pie Apple and Sieved Apple ..	N. A.	N. A.	N. A.	N. A.	N. A.	327,800	643,000	N. A.
Jams and Jellies ...	1,530,000 (a)	-	-	2,672,000	2,884,000	3,576,000	2,396,000	2,300,000

NOTE : "N.A." - Statistics not available.

References : (22) (23) (26)

(a) 1939 pack only

5. Tropical Fruits

The pack of pineapples in the form of slices, segments and pineapple juice has been increasing steadily. Canning capacity was increased immediately after the war by the installation of a second large plant with the conventional high-speed equipment. The canning of tropical fruit salad was continued throughout the war and is now being exported in a small way; this product consists principally of pineapple segments with small proportions of cubed papaya, passion fruit pulp and sometimes slices of banana.

Experiments are being carried on also in the canning of papaya in syrup, passion fruit pulp, mango products, and blends of passion fruit juice with other fruit juices. Canned bananas in acidified syrup (8) have been put up during the past three years. The packing of this latter product in some cases has included the use of calcium chloride for the purpose of firming the fruit. On occasions discoloration has been found in canned bananas, apparently associated with improper maturity of the fruit, lack of sufficient sterilizing treatment, or excessive headspace in the cans.

6. Fruits Juices

Experimental canning of citrus juices represented one of the first canning research projects with which the Division of Food Preservation of the C.S.I.R.O. was concerned. A considerable amount of canned citrus juice was put up during the war for the military services, but these products have not gained high popularity with the Australian consuming public since the war. One of the factors which may have contributed to this lack of popularity was the postwar release from military stocks to the retail trade of considerable quantities of over-age canned citrus juice.

Early experimental work by the C.S.I.R.O. confirmed the overseas experience that Washington Navel oranges, which make up about half of the Australian crop, were unsuitable for canning of orange juice because of presence of the bitter principle, limonin. While Valencia oranges normally were satisfactory for juice, instances later were observed (6) (10) when Valencia oranges were found to be bitter because of limonin content; this defect was found to be correlated with the use of copper-bearing fungicidal sprays.

The deterioration of canned orange juice stored at ordinary temperature, involving both the diminishing of ascorbic acid content and the development of "stale" flavors, led to experimental work by the C.S.I.R.O. (9) in checking the role of oxygen in such deterioration. Reducing the initial oxygen content of the juice to a very low level failed to inhibit either loss of ascorbic acid or flavor deterioration. Studies in the non-oxidative destruction of ascorbic acid (8) have been undertaken.

IV. RESEARCH RELATING TO THE CANNING OF VEGETABLES

Prior to World War II, the canning of vegetables had made considerable progress in bluiding up a public demand. During the war, a vast expansion was made in the acreage of vegetables for canning to supply the demands of the military services. While a limited advance in volume was made in the case of the more choice vegetables such as asparagus, the greater increase to supply the services was made in vegetable crops of which rapid expansion in acreage was possible. Many of these would not ordinarily be considered popular peacetime items which the public would buy in cans to any great extent. In the postwar period, the volumes of these latter vegetables have returned to their ranks of lesser importance, and the more choice canned vegetables have gone to the fore. (See Table II).

TABLE II

AUSTRALIAN PRODUCTION OF CANNED VEGETABLES - UNIT : CASES OF 24 No. 2 1/2 CANS

VEGETABLES	1939	1943	1944	1945	1946	1947	1948	1949	1950
Asparagus ...	51,200	67,700	65,500	60,800	51,900	-	55,400	94,900	-
Beans	55,400	233,500	136,400	280,000	223,500	-	251,000	496,300	-
Beetroot	(a)	(a)	184,000	386,000	260,000	-	18,200	35,500	-
Cabbages	(a)	(a)	316,000	24,000	45,700	-	(a)	(a)	-
Carrots	(a)	(a)	304,500	926,000	426,000	-	23,300	56,400	-
Cauliflower .	4,700	6,600	4,800	(a)	(a)	-	(a)	(a)	-
Peas	44,300	85,500	222,500	400,000	548,000	-	540,000	362,400	-
Silver Beet . (b)	(a)	(a)	42,700	178,500	58,400	-	(a)	(a)	-
Tomatoes .... (c)	37,600	216,500	170,000	177,000	97,600	-	72,100	93,600	-
Other Vegetables . (d)	47,100	1,104,000	814,000	396,000	810,000	-	122,700	153,800	-
	240,300	1,713,800	2,260,400	2,828,300	2,511,100	1,359,000	1,082,700	1,292,900	1,770,000

(a) Included in "Other Vegetables"

(b) Synonymous with "Swiss Chard"

(c) Includes Tomatoes Only, not Tomato Products

(d) Includes Parsnips, Potatoes, Turnips, Sweet Corn,etc.

References : (23) (25) (26).

1. Green Peas

The canning of peas underwent considerable expansion during the war, made possible partially by the increased manufacture of canning equipment in Australia and partially by the help of machinery brought in under the Lease - Lend arrangement. All of the factories now canning peas are equipped with the high - speed harvesting, vining and canning equipment which is more or less standard throughout the world.

In varietal selections, the trend since the war has been to adopt pea varieties (8) which have been found to do well particularly in Australia. Since no quality graders employing the brine flotation system are in use in the Australian pea canneries, considerable work has been carried to facilitate the harvesting of peas near the optimum canning maturity. Over several years, a large volume of information has been accumulated by the C.S.I.R.O. and the State Departments of Agriculture to establish the relationship which exists in Australia between " Tenderometer " tests for maturity and alcohol-insoluble-solids (A.I.S.) content of the canned peas. A significant development by the C.S.I.R.O. has been the designing of an instrument called the " Maturometer " with which a maturity test can be made (11) to yield the same information as the "Tenderometer". This instrument, which is compact and portable, is soon to be manufactured in Australia for the use of canners and freezers of green peas.

2. Asparagus

A significant development in the production of asparagus for canning has been the adoption of the newer strains of Mary Washington variety. Although the culturally - bleached canned asparagus made up the entire pack prior to 1947, one major cannery has been packing entirely the all-green style of pack since that date, and this product appears to be finding ready consumer acceptance.

3. Green Beans

Green beans have never made up a significant proportion of the Australian canned vegetable pack,

and it is difficult to obtain accurate statistics, since the pack statistics are generally compiled with those of the dry bean packs. Since the war, this vegetable has become more important with the use of improved varieties of the green bush beans, as well as the adoption by some canners of the Blue Lake type of climbing or pole beans. The Julienne type of pack is one of the more favored styles of canning in Australia.

4. Sweet Corn

The canning of sweet corn was initiated during World War II at the request of the U.S. Army. Since that time the acreage of corn for canning, made up of the Golden Cross Bantam hybrid type, has been increased materially. Until the last two years, cream-style corn made up the entire pack, but tests have been made recently on the whole kernel style of pack, and there are indications that the consuming public may find this more popular.

5. Beets

During the war, canners were asked to adopt the canned beet pack which was acidified by the addition of vinegar, in order to provide a product which would be more palatable in use for military rations. Although this practice of acidifying served to bring the pH to below 4.5, the same sterilizing process was employed as for the non-acidified pack. Since the war this practice of acidification has been continued for virtually all of the beet pack. The practice of acidification has shortened the shelf life of this canned product so that can failures may be expected if the product remains unconsumed much beyond two years after packing.

6. Sauerkraut

Sauerkraut represented another canned vegetable which was initiated by the U.S. military forces in Australia. Limited quantities of this product have been canned in the postwar period, and interest is increasing, possibly because of the numbers of mid-European peoples among those who have migrated to Australia since the war. Some difficulties have been encountered in the fermentation of sauerkraut for the reason that much of the supply of cabbage for this purpose is available during the warmer seasons, and therefore it is more difficult to regulate the temperature of fermentation.

7. Tomatoes and tomato products

While the canning of whole tomatoes gained considerably during the war, the pack has slipped back to a minor place (Table II, p.5) in the postwar statistics. It is far out-weighed by the canning of tomato juice, tomato soup, and tomato paste, in addition to the packing of tomato pulp for manufacturing purposes during the off-season. (Principally in 4-Imperial-gallon square cans).

Tomato juice became important during the war in the supply of military rations, and it first appeared to be taking on well in the postwar civilian market. However, the pack seems to be losing ground; the volume dropped from 474,000 cases (basis of 48 - 301 x 411 cans) in 1948 to 159,000 cases in 1949.

The outstanding utilization of tomatoes is in the canning of soups. The 1948 Australian pack of canned soups was equivalent to 565,000 cases (basis 48 - 301 x 411 cans) of which 92 percent was of tomato soup; in the following year of 1949, this pack was nearly doubled to 1,120,000 cases of soup, of which 82 percent was tomato soup.

The small amount of tomato paste which formarly was canned from small, batch-operated vacuum concentrators was augmented in 1949 by the importation of one Buflovac continuous concentrator; the output is being packed into No. 10 cans for export and 4-gallon square cans for domestic use.

Tomato pulp used for manufacturing purposes during the off-season is largely concentrated in open kettles and is packed into 4-gallon square cans. Efforts are being made in the Industry to agree on a standards specific gravity for tomato pulp to provide a common basis for purchasing.

Extensive varietal selection work is being carried on by the State Departments of Agriculture, as well as by the canning crops supervisors of the principal canning companies. While a number of varieties of American origin have shown up well, the industry is finding the good quality domestic varieties of Tatura Dwarf Globe and Tatinter to be dependable under Australian growing conditions.

V. CANNING OF MEAT PRODUCTS

The canning of meats has undergone a large expansion of volume as well as a market increase in new styles of pack. Prior to the war the meat canned was mainly corned beef and corned mutton, various styles of canned tongue, sausages, and a few styles of formulated packs. During the war a number of new types of meat packs was undertaken to fulfill requirements of the armed services of the several Allied countries operating in the Pacific Area. As a result of this diversification, new meat products were available to the Australian consuming public after the war.

These included packs of meat and vegetables, luncheon meat, Vienna sausage, as well as canned ham

and canned bacon. The canning of rabbit meat has increased to a point where it is second only to canned beef in volume (See Table III).

TABLE III

AUSTRALIAN PRODUCTION OF CANNED MEATS - UNIT : '000 LB

CANNED MEAT PRODUCT	1939	1945	1948	1949	1950(a)
Beef	--	--	71,553	63,005	--
Mutton	--	--	2,959	3,938	--
Meat and Vegetables	--	--	4,165	4,889	--
Tongues (Beef, Sheep & Pork)	--	--	1,135	903	--
Sausages	--	--	3,390	1,857	--
Ham and Bacon	--	--	4,170	3,419	--
Rabbits	--	--	9,769	13,415	--
Other (including Poultry and Game)	--	--	24,939	22,717	--
	32,161	167,609	122,080	114,143	126,601

(a) Subject to revision. References (24) (25) (26).

Ham in recent years has been packed both in the large pear-shaped cans and the 401 x 411 open - top cans. Immediately after the war some companies attempted to market the canned ham as a sterile product when stored at ordinary temperatures. However, it was soon learned that heat processes which avoided excessive rendering of the fat necessitated addition of the legend on the label : "Perishable -- Store In A Cool Place".

VI. CANNING OF MARINE PRODUCTS

Canning of fish was begun in Australia well before 1900, but exploitation of the fisheries for this purpose has lagged. Principal among the reasons for this slow development has been that knowledge was lacking regarding the location of fishing grounds, of the migrations and other habits of species of commercial importance, and of suitable methods of taking different varieties under conditions found in Australia waters. The major part of the pack at present is made up (12) of types of fish, such as Australian salmon and barracouta, which do not produce canned products of high quality, therefore, both from the standpoint of the domestic market and of the export market, it is evident already that either the processing methods used to can three species must be improved or the industry must search out fish species of higher quality.

1. Australian Salmon

The Australian "salmon" (Arripis trutta) has been unfortunately named in that it bears little resemblance to true species of salmon. It occurs along sheltered beaches and is taken by beach seine. It is found along the Southern coast from Southwestern Australia, including Tasmanian waters, as far up the East coast as Sydney. The usual tough texture of some of the muscles can be improved (8) (12) by pre-brining until the fish absorbs about 2% its weight of salt. Also some portions of the fish which are brown when canned normally may be changed to a reddish-pink color by addition of a small proportion of nitrite to the brine.

2. Barracouta

Barracouta (Thyrsites atun), which appears to be identical to South African "Snoek", with Australian " salmon " makes up approximately 80 percent of the Australian pack of canned fish. A light smoking before canning has been found (12) to improve the flavor of barracouta.

3. Pilchards and anchovies

Pilchards (Sardinops neophilchardus) have been taken in the waters of both Western Australia and Victoria, and limited canning trials in both of these states have produced good quality products. Further development will require installation of suitable canning equipment as well as a more highly organized program of catching.

Anchovies (Engraulis australis) are best known in the south where they appear to be in abundant supply in Victoria waters. The catch, which now approximates 100,000 lbs annually, could be increased greatly, should there be more demand for processing.

4. Tuna and Allied Species

An aerial survey of the coastal waters of Australia by the C.S.I.R.O. Division of Fisheries was interrupted by the war in 1939. However, these surveys showed the presence of tuna in schools of significant size and variety. In the postwar period, there was little commercial fishing for tuna until 1949 when trolling for Southern Bluefin (Thunnus maccoyii) in New South Wales waters yielded several hundred tons of fish for a cannery in that area. In 1950 an overseas "tuna clipper" demonstrated in those same waters that pole-fishing could be used also to take these fish. Surveys have shown (12) that albacore (Thunnus germo) and Striped Tuna (Katsuwonis pelamis) and Southern Blue fin (Thunnus maccoyii) are present in significant quantities. Other species which have been identified, but which may not be of economic importance are : Yellowfin tuna (Neothunnus macropterus), Northern Bluefin (Kishinoella tonggol), Dogtooth tuna (Gymnosarda nuda), Mackerel tuna (Euthynnus alletteratus), Bonito (Sarda australis), and Oriental Bonito (Sarda orientalis).

The tuna canned in Australia has had a good reception, both in the home and export markets. This development is one of the brightest factors in the future of Australian fish canning.

5. Other Fish

Spanish mackerel (Scomberomorus) occurs off the Queensland coast, where it is important in the fresh market, and off Western Australia, where successful canning trials point the way toward greater utilization of this fishery resource.

Tasmanian whitebait (principally Lovettia sealii) has been canned for many years, in some cases by canneries on the mainland using frozen fish. Experiments have shown, however, that the product of best quality (12) is obtained by eliminating freezing and canning the fish on the same day they are caught.

6. Shellfish

There has been limited canning of scallops in Tasmania where the fishery is dependent on the Commercial scallop (Notovola meridionalis).

Rock oysters (Saxostrea commercialis), propagated along the Eastern coast of Australia find a good market, sold as fresh or bottled in brine; from a cost standpoint it has not been practical to can them. However, some native rock oysters from the Queensland Barrier Reef have been used in canning oyster soup. Since 1947 efforts have been made to introduce the Pacific oyster (Ostrea gigas) into the waters of both Western Australia and Tasmania; this appears to have been successful only in Tasmania. If this species becomes acclimatized, it may form the basis of a new canning activity.

TABLE IV

AUSTRALIAN PRODUCTION OF CANNED FISH (a) - UNIT : POUNDS EDIBLE WEIGHT

1939	1945	1946	1947	1948	1949	1950 (b)
603,302	1,038,771	1,683,612	3,717,248	12,228,117	10,886,254	6,961,000

(a) Excludes shell-fish and fish paste (Includes fish loaf.)

(b) Subject to revision.

References : (12) (25).

7. Crustacea

a) Crayfish

Important fisheries for the large marine crayfish are exploited in all of the Southern States of Australia : for Jasus verreauxi in New South Wales; for Jasus lalandii in Victoria, Tasmania and South Australia; and for Panulirus longipes in Western Australia. The catch in New South Wales and Victoria is used to supply the fresh market in those areas. In the three other states in which crayfish are plentiful, a considerable amount is available for processing. Although some canning as " rock lobster " is carried on in South Australia and Western Australia, the newly-established U.S.A. market for frozen crayfish is absorbing most of this surplus over - and - above fresh market requirements. Occasional difficulty with darkening of processed crayfish (8) (13) has been correlated with high blood copper, and processing methods have been altered to correct for the highest copper values yet encountered.

b) Prawns

The prawn fishery of Australia is second in size to that of the U.S.A., although much smaller in

extent. Previously the fresh market absorbed the catch, but with the recent discovery of new prawning grounds off the coast of New South Wales, interest in canning of prawns has been revived. Investigations along these lines are being conducted by the C.S.I.R.O. Division of Food Preservation.. The main species (12) are the Tiger prawn (Penaeus esculentus) in southern Queensland, the Queensland, the King prawn (Penaeus plebejus) and the School prawn (Penaeopsis macleayi) in New South Wales, and Penaeus monoceros, related to prawns of Indian waters, in the small fishery of Western Australia.

VII. CANNING OF DAIRY PRODUCTS

Since 1939, statistics indicate that the overall production of all processed dairy products has almost tripled; however, clear-cut production figures which would show the increase in the respective canned dairy products are not readily available.

I. Condensed Milk Products

The 1948 production of " condensed milk ", sweetened and unsweetened, was 45,595 tons. Since that time, three large overseas dairy products canners have installed milk canneries, or are in the process of doing so, both to take advantage of the comparatively low cost of raw milk in Australia and to be able to supply the Far East market from a nearby " soft currency " area. The "condensed" milk, both sweetened and unsweetened, is packed in open-top cans.

2. Butter

During the war, "Tropical Butter Spread", a high melting-point, dehydrated butter spread was vacuum-sealed in cans for the U.S.A. and Australian military forces in the Pacific Area. Since the war, a similar canned butter has been exported to some extent. There is also a considerable export trade in regular butter (14) packed in 1-lb. cans.

3. Processed Cheese

Cheddar Cheese is distributed on the domestic market mainly as packaged foil - wrapped processed cheese. Large quantities were canned as military rations during the war, and this pack in 1-lb. cans has been continued as an important export item.

VIII. C. S. I. R. O. OTHER RESEARCH RELATING TO CANNING

I. Microbiology

Investigation into the occurence of Cl. botulinum in Australian soils (15) was stimulated by two outbreaks of botulism in Australian canned vegetables in 1942. Although Cl. botulinum Type B had been implicated previously in several outbreaks of livestock poisoning, Type A had not been found. However, by collection of samples of virgin soil from wide - spread sections of the State of Victoria, a few strains of Cl. botulinum Type A were isolated from the soils of one general area. In subsequent studies with these and other strains, it was noticed (16) that Cl. botulinum grew in certain vegetables packed in internally lacquered cans, but not in the same vegetables packed in plain (unlacquered) cans. It was concluded that the greater concentration of tin dissolved by the product from the plain cans was providing a bacteriostatic effect on the organisms. Further work, including a wider variety of canned vegetables, showed (17) that the concentration of tin necessary to produce the bacteriostatic action varied widely among the different vegetables, with an apparent correlation with protein content of the respective vegetables; i.e., the higher the protein content the higher the concentration of dissolved tin required to produce the bacteriostatic action.

Studies were conducted (8) on the nature of substances in the liquor of canned vegetables which displayed a protective effect against the destruction by heat of the toxin of Cl. botulinum Type A. Different vegetables varied in the tendency to exert the protective influence. The heat stability of the toxin was found to be due to various ionized substances, both anions and cations, which tended to have an additive effect.

Experimental work in stimulating the germination of bacterial spores by sub-lethal heating indicated (8) that media contained certain substances which inhibited spore germination. Increased recovery in media containing starch, serum albumin or activated charcoal led to the belief that the inhibitory substances were being absorbed upon these additives; the nature of the inhibitors was believed to be unsaturated fatty acids, having an effect similar to that known to occur in the presence of linoleic acid.

2. Chemical Studies

In connection with deaeration studies in the canning of orange juice, a simple, rapid, and accurate polarographic technique was developed (18) for the determination of dissolved oxygen.

A research program which required a large number of determinations of dissolved tin and iron in canned foods led to a critical evaluation of the analytical methods in use (19) (20) and the adoption of helpful modifications.

3. Evaluation of Thermal Processes

A study was made (21) of the logical and mathematical basis of the usual means of evaluating thermal processes for canned foods, with a view to correcting for certain errors which appear to be possible in the methods used at the present time.

IX. STANDARDS OF QUALITY FOR AUSTRALIAN CANNED FOODS

1. For Export

All canned foods, to qualify for export from Australia, must conform to Export Regulations administered by the Commonwealth Department of Commerce and Agriculture. To qualify for export, the foods must be canned in an establishment approved by the Department as conforming to its Regulations regarding cleanliness, proper equipment, and personnel skilled in the processes involved. An inspector of the Department makes frequent checks on the packing operations and passes for export only that portion of the pack which conforms to the Export Quality grades. The Commonwealth inspection service does not concern itself with canned foods packed for consumption within Australia.

2. For Domestic Consumption

While the only regulations which apply to canned foods consumed in Australia are those contained in the Food Regulations of the State in which they are offered for sale, thus far there have been very few specific rules which apply to canned food quality; more usually those sections which apply to canned foods mention quality only in general terms, such as specifying that vegetables used for canning shall be "succulent". The increase in canning for domestic consumption in the postwar years, however, has led to agitation for more safe-guards for the consumer, particularly in regard to fill-of container; action along these lines in revising the Food Regulations of the respective states no doubt will include some form of minimum limits of quality.

X. MACHINERY DEVELOPMENTS IN THE CANNING INDUSTRY

1. Crop Production

For Australia to expand her acreage of canning crops so extensively during the war, it was necessary to mechanize highly the canning crops production. Many tractors were imported, but much equipment was produced by local machinery manufacturers. Since the war, the growth of secondary industry has resulted in almost as serious a labor shortage as in wartime; consequently, the tendency toward mechanization of field crop operations hat not diminished.

2. Canning Operations

As in the field production side, competition for the limited supply of labor has made necessary more extensive adoption of mechanical aids to processing. The automatic pear peelers were in use before the war, while the high- speed clingstone peach splitters and pitters were installed immediately after the war; both of these machines are imported. However, long before the war, several canning equipment manufacturers were supplying to the Industry such equipment as fillers, syrupers, exhaust boxes, continuous rotary cookers, blanchers and graders. During the past two years, some of the principal seasonal fruit canneries have installed processing equipment of advanced design which promises to set the pace for the industry. These fruit canning lines include pre- vacuumizing syrupers, followed by steam-vacuum, high- speed closing machines and continuous rotary pressure cookers and coolers. Although most of the original installations were imported, all of these types of units are now being manufactured in Australia.

3. Can Closing Machines

The Troyer-Fox 9 D.S.-type of closing machine has been the "work-horse" of can closing in the Australian canning industry; in addition to machines of this type imported from the U.S.A. and England, three Australian manufacturers have produced similar machines. In the early years of the war, the first 4-head closing machine to be made in Australia was put into operation, and in addition, a few American 4- head machines were imported under the Lease - Lend agreement. The high rate of production of the special military meat ration packs led to the introduction of high-speed vacuum closing machines to augment the hand operated

acuum closing machined used in some plants, and, in other cases, to replace the "clinch-cover" exhaust treat-
ent which was used to a large extent. For the new fast fruit canning lines, six-head steam-vacuum closing
achines are now being made in Australia, in addition to those which have been imported for that purpose.

I. IMPROVEMENT OF CAN SUPPLY

During the early days of the Australian canning industry, a high proportion of cans were made by he canning companies who used them. One of the reasons for this was that there were few alternative sources f cans of dependable quality. Another reason was the serious problem of transportation of made-up cans to any of the widely dispersed cannery locations, particularly of the meat canning factories along virtually ,000 miles of the Queensland coast. Since the war, some of the canners, accessible to can-making factories, ave terminated their own can manufacturing activities.

With this increased centralization of can manufacturing, it has already been possible to take steps oward greater standardization of can sizes, particularly in eliminating some can diameters which were used nly by individual canners.

Since the war, one can manufacturing company and two can machinery firms have commenced the building f can body-makers capable of speeds of approximately 325 cans per minute. With the replacement of slow, bsolete can-making equipment, the quality of open-top cans for processed foods will be improved considerably.

Until early 1951, electrolytic tin plate had not been used commercially in Australia for the manu- acture of open-top cans for processed foods. However, during each of the three prior canning seasons, ex- erimental packs of various fruits and vegetables were made by a committee appointed from the canning indus- ry to act in an advisory capacity to the Commonwealth Tin Plate Board. These experimental packs were kept nder observation at elevated temperatures, at first by industry laboratories, and later by the C.S.I.R.O. ivision of Food Preservation. The results of these observations have indicated that cans made wholly or n part of electrolytic tin plate have shown under Australian canning conditions a shelf life equal to that f similar food products included in the studies conducted in the U.S.A. under the substitute container esearch program of the Can Manufacturers Institute. It now appears certain that, by late 1951, electrolytic in plate will be in large-scale use by Australian manufacturers of open-top cans.

XII. CONCLUSION

A review of the developments which have taken place in the Australian canning industry since 1938 as served to reveal not only the remarkable growth which has taken place in the overall volume of produc- ion, but also to give some hint as to what may lie ahead for different sections of the Industry.

Statistics when considered alone would be misleading; as in the case of canned peaches, pack sta- istics will not show the immense amount of work which has gone into selection of new varieties which promise, ithin the next few years, to reduce the cost both of fruit production and of processing in the canneries, nd to raise the standard of quality of the canned fruit. Neither do the statistics covering the canning of arine products, which indicate an adverse trend recently, show the extensive surveys of fishery populations hat will lead eventually to more wide-spread drawing upon resources of fish known to be desirable for can- ing purpose.

The Australian canning industry in general has emerged from this decade aware that it is in a strong osition, technologically, with the support which it can command from the technical service agencies asso- ciated with it, the next few years may see even greater progress.

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X. TECHNICAL PROGRESS IN THE BELGIAN CANNING INDUSTRY SINCE 1938

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I. INTRODUCTION

We had hoped to present a detailed study rich in statistics and graphs, which would have enabled us to express in figures, the progress realised since 1938, in the Belgian Canning Industry, and perhaps to draw some lessons from the past.

It has proved very difficult to collect all the necessary information and also, many other duties have taken up our time. We have been obliged, therefore, to deal rather summarily with the developments in Belgium since 1938.

We hope that those of our readers who would like further information will not hesitate to write to us.

II. VEGETABLE CANNERIES

All the Belgian Canneries have been re-equipped since the end of the German occupation. The larger factories which produce the greater part of Belgian Canned Vegetables, have mostly followed American techniques, and because of that we consider our industry among the most modern in the world, and the average technical level reached today, at least equal to that of the North American industry.

The Belgian Canners have been able to buy freely, all the equipment they needed. They have largely used Belgian made equipment based on American design and equipment made in America and Great Britain, but France and other countries have also supplied equipment on a smaller scale.

Since the Belgian industry has adopted foreign techniques, largely from the U.S.A., we are unable to give here, any original Belgian developments. We can only briefly cite the adaptations which have been carried out since 1938 and particularly since 1945.

It must be remembered that the Belgian Vegetable Canners joined together in 1945 to set up an Agricultural and Technical Research Institute : The National Institute for the improvement of Canned Vegetables (INACOL). This institute which was founded and designed after close study of similar institutions in other countries, has possessed since 1949, a Research Station containing amongst other things, a very well equipped laboratory and a pilot canning plant. It is thus able to assist the industry in other fields, including that of raw materials. It must be remembered also, that the manufacture of canning equipment in Belgium, has developed very much since 1945 and this has had a good effect on the level of technical development in our canneries.

1. Progress since 1938 and chiefly since 1945

Manufacturing processes have been greatly mechanised and the main canneries now have available continuous production lines for many products.

The vining of peas has made great progress and takes place either in the factory or in large vining stations in the fields.

Podders have been retained and are kept mostly for peas containing a large number of "extra - fins" and for deliveries coming from areas of small production.

Hydraulic conveying is much used either by pumps, flumes or separators, both for podded or vined peas as well as for graded peas. Frequently chlorinated water is used for fluming and washing.

"Brine Quality Graders" are extensively used and are usually placed before the blanchers, but good results are also obtained by grading blanched peas. More use is being made of continuous blanchers for "extra-fins" peas as well as for those vegetables which, before the war, were blanched in pans.

Canned peas are not generally exhausted but boiling brine is added and the peas filled hot. In the latter case the peas are washed in warm water after blanching or, if they have been cooled, are heated immediately before going to the filling hopper.

Automatic high speed fillers and seamers are becoming standard everywhere and there is a tendency to an increase in mechanisation and speed of output.

Hoppers in Plexiglass fed by electric vibrators are being used more and more.

The conveying of empty and filled cans is being mechanised, particularly in those factories which use continuous sterilisers.

The coding of cans has increased as well as the use of various measures permitting closer control of manufacture.

Continuous sterilisers are much used, one in particular having an output of 300 cans per minute. Some canners have adopted as well as continuous sterilisers, large horizontal retorts with quick opening doors at either end. The crates are carried on lifting trucks and after retorting the crates are emptied automatically and the cans are handled and conveyed mechanically (American Dumpers and Unscramblers).

The use of pressure cooling has made progress even in factories which use small vertical retorts.

More than half the production of Belgian canned vegetables is cooled in chlorinated water and in a short time all canners will use this method. The water is chlorinated to break point and a number of canners use "in plant" chlorination except for blanching water, brine and boiler feed water. For this letter, the recovery of hot chlorinated water is being considered.

Automatic labelling is generally used and to a lesser degree automatic carton filling.

Wooden cases have been replaced by cartons and decorated cans by labelled cans. However, some decorated cans are still used by everybody, particularly for tomato puree, and some factories still prefer decorated cans. Other use both decorated and labelled ones.

Several canners label, carton and put into stock immediately after packing and in fact, losses from blowing are tending to disappear. This is a result of an improvement in the quality of the cans and above all, of the fact that the cans are closed very hot (above 80°C in many cases), and that the canners seams are now better controlled. It should be noted that the control of seaming of cans has become very strict. Several can makers and canners carry out regular Bio Tests on large numbers of samples.

Many warehouses have been improved and mechanised and the handling of cartons on pallets and the movement of these by lifting trucks is frequent.

There is a tendency to use more internally lacquered cans and also to use cans with the ends lacquered externally, so as to improve the appearance of the labelled cans.

The washing of spinach after the dry removal of sand has been improved, compared with before the war, the number of water washes has been increased and the spinach is subjected to numerous washes in increasingly clean water.

The handling of green beans has been mechanised in many factories. Continuous snibbers and graders, automatic cutters and graders for cut beans and automatic fillers of many types, are used.

Carrots and similar vegetables are more and more handled on automatic lines and steam peeling or continuous lye peeling, followed by abrasion, is often used.

New machines for cutting macedoine have been installed and in addition to standard fillers, many canneries use for beans, carrots, etc..., cut in pieces of not more than 30 mm, the well known " Hand Pack " fillers equipped either for automatic or hand filling and with attachments for shaking, pressing and brining.

2. General progress

There is a tendency to use first class equipment driven by individual motors and which is easy t[o] move about. The use of stainless metals is becoming more and more common and great progress has been mad[e] in the cleaning of equipment. The surfaces of many machines are kept under jets of chlorinated water an[d] thus are maintained in a clean condition and modern cleaning machines are also frequently used.

It should also be noted that as well as modernising the equipment, a big effort has been made t[o] improve quality control. Many canneries have laboratories and all can call on INACOL for assistance.

The control of vegetables as well in the cannery as during growth, has been greatly developed. N[o] matter what equipment he has available, the canner can only produce a good product if his raw materials ar[e]

first class, and this is very well understood by the Belgian canners and growers, who work together very closely.

III. FRUIT CANNERIES

Here there has been marked technical progress although by no means as revolutionary as in the vegetable canneries.

The equipment existing in 1938 is still generally used but it has been greatly improved.

For canned apples, automatic peelers are generally used and continuous cookers have been installed for the manufacture of fruit sauces.

For cherries a new type of stemmer has been developed but this has not replaced the older models. One canner is shortly trying a thermopeeler for plums. Exhausting is becoming generally used and rotary continuous sterilisers are becoming more and more common.

Water cooling is standard but no canner uses chlorination.

Glass containers are now of the light weight type with either aluminium or lacquered tinplate caps. They are still cooled in air on trays but cooling by means of a water mist in under consideration.

Automatic labelling is general as well as the use of small cartons. There has been a marked improvement in design and presentation.

IV. JAM PACKERS

There has been a tendency more and more to replace the storage of fruit in SO_2, by cold storage, particularly for strawberries, raspberries, bilberries and also for cherries and apricots.

Canned pineapples, peaches and apricots are also imported.

Some jam makers use vacuum cookers holding batches of 3 - 500 kilos. It is, however, necessary first of all to remove SO_2 by boiling in pans. Most pans are still made of copper but there is a tendency to replace this by a stainless metal. Most factories have installed automatic fillers and use jars which can be closed automatically by aluminium caps. The jars are filled hot, sterilised in steam in a machine similar to an exhaust box, and then generally are cooled by means of a water mist.

It should be noticed that since the war there has been a marked increase in technical control and, in the principal factories, the laboratory exercises strict supervision over the products, which are of first class quality.

V. MEAT CANNERIES

Belgian meat canneries pack mostly cured products and prepared dishes rather than the more standard types of canned meat. However, corned beef is made for the Army and luncheon meat for the Army and for export. Because of this it has not been possible greatly, to mechanise production except after filling. Automatic fillers for pastes, conveyor belts and automatic seamers (60 cans per minute) are now frequently used.

For the large sizes of can, closure by soldering under vacuum is still employed.

There is a tendency towards the use of pressure cooling but the water is not sterilised.

The fittings of retorts have been improved and more and more automatic controls are used.

Exhausting is not practised but sausages are packed with the addition of hot brine and stews etc., are filled hot.

The installation of vacuum mixers and cutters is being seriously considered, but to the best of our knowledge no such machines have yet been installed.

The practice of coding cans has increased and the use of decorated cans is decreasing. Certain factories label all their cans. Labelling is generally done automatically for round as well ar for certain irregular cans. There is a marked tendency towards the standardisation of can sizes following the work of the C.I.P.C.

Since canned meats are not usually held long in stock, warehouses have not markedly improved. Small canneries have put in refrigerators and the larger canneries have adequate cold storage capacity from before the war.

The equipment in general has not been greatly modified, but although unchanged in principle the construction has been improved. More and more stainless steel is being used or if this is too costly, it is replaced by aluminium.

Quality control has increased and more and more skilled labour, which has been given technical instruction, is being used.

Control of processes by incubation is now general, and canned meats for export have been, for the last two years, carefully controlled at every stage by the Veterinary Service of the Ministry of Public Health.

Finally, control of production for the home market is still optional but it is extremely likely than even if it does not become obligatory, all packers will ask for it.

VI. FISH CANNERIES

The canned fish products which are made in Belgium are marinated herrings, herrings in tomato sauce, marinated mackerel, sprats, fillets of mackerel and shrimps.

As a result, the progress made since 1938, in mechanisation, has been in Belgium, as everywhere, relatively small. One exception is the automatic cooker, one of which has been installed, and the use of which is likely to increase.

I. General progress

The use of pressure cooling in extending and the chlorination of cooling water in increasing. Sometimes large horizontal retorts with two quick opening doors are used. The crates are carried by lifting trucks and emptied mechanically after retorting and cooling. One factory has sterilised in super heated water since before the war, but generally retorting in steam is the standard procedure. Only improvements in detail have been made.

Only tinplate cans are used and sterilising under super pressure of air is not used.

Several systems for cooking fish are in use and since 1945 one factory has installed a hot air cooking tunnel (Masso System).

Cans are either decorated or labelled according to the factory or the shape of the can.

Wood cases have been replaced by cartons and for certain acid packs, plastic flexible containers are beginning to be used.

Control of the quality of production has been much improved and the larger canneries now have laboratories.

It should be noted that the increasing use of stainless metals has led to more easily cleaned equipment and better methods of hygiene.

VII. QUICK-FREEZING

I. Fruits and vegetables

The quick freezing of fruits and vegetables began in Belgium during the war. After the liberation a factory which had been sequestrated, was bought by an important Belgian firm. It was enlarged and improved and at the present time has the standard equipment of a fruit and vegetable cannery of medium size and good jam making equipment. It also has a quick freezing tunnel of the "Linde" (German) type, (minus 40° to 45°C) and refrigerated warehouses.

The factory which is scientifically controlled, works according to modern techniques and has an excellent laboratory and staff. It is, therefore, at the level of the best fruit and vegetable canneries.

Nothing outstanding can be noted concerning quick freezing. Vegetables of the highest quality are frozen in bulk (25 pounds), in wax cartons or in cellophane wrapped packets.

Fruits are packed in wax cartons lined with aluminium foil.

Some fruits are treated with citric and ascorbic acids.

Raw materials for the manufacture of jams are frozen in bulk.

2. Fish

A factory for the quick freezing of fish has been recently built in Ostend.

Since 1949 the following products have been prepared : Cod, Mullet, Haddock, White Salmon, Soles, Skate, Shrimps.

The fish is cut, skinned and boned and the fillets wrapped in two layers of cellophane, the second of which is heat sealed. They are then packed in wax cartons.

Quick freezing is carried out in a tunnel using cold air at minus 40° to 45°C, the containers being placed on trays carried on rails (Niagara Blowers Method).

This factory is most modern and highly mechanised and is, to the best of our knowledge, the largest and most up to date on the Continent.

It also has an ice making factory using the American Vogt method (tube ice), and a fish meal factory where the 50 to 60 per cent of waste from the quick freezing factory is ground and gradually dried.

Even though we have not given any figures for the other industries we think it will be interesting in this particular case, to give some idea of the importance and size of the factory.

It can produce daily 200 tons of ice and handle nearly 125 tons of fresh fish and 80 tons of fish waste for drying.

XI. THE CANNING INDUSTRY IN SPAIN MORE ESPECIALLY WITH REGARD TO FISH

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I. INTRODUCTION

Before giving a short account of the development of the food canning industry in Spain during the last twelve years, I must point out that, due to internal and external circumstances, the industry has been subjected for all this period to very severe control of distribution of raw materials (tin-plate, tin, olive oil and sometimes even fish) which has frequently handicapped its technical progress.

However, a system of commercial freedom is drawing near and, we hope, will have become effective by the time this report is published.

Raw materials are distributed at present on the basis of consumption in 1935. As regards tin-plate, allocations to the different branches of industry are as follows :

Fruit canning industry (of which 62.3 % for the Galicia fish canning industry)	32.5 %
Fruit and vegetable canning industry	25.5 %
Processed milk industry	4.1 %
Tin printing industry	28.8 %
Other industries	9.1 %

Although there is no limit to the possibilities of obtaining supplies of fruit and vegetables, the most important canning industry in Spain is that concerned with fish and shell-fish. This has always been the case, not only historically (the first factories were probably set up in 1840 and official records dating back to 1869 exist), but also from the point of view of exports. (Table I).

TABLE I. SPANISH EXPORTS OF PRESERVED FISH

Year	Sardines	Other fish	Cured fish
	Metric tons		
1931	20,328.3	15,684.3	4,312.6
1932	16,140.9	11,825.9	3,725.2
1933	16,732.0	8,200.5	3,027.9
1934	20,450.0	7,384.7	1,650.9
1935	21,762.5	6,193.7	1,510.4
1936	4,161.2	1,241.0	297.2
1942	2,401.2	2,996.3	5,295.7
1943	1,624.2	1,127.1	11,532.8
1944	613.8	909.0	374.0
1945	1,786,5	3,562.1	1,546.7
1946	3,339.9	1,431.9	596.0
1947	2,442.9	3,033.5	3,832.9
1948	3,173.5	2,500.9	997.9
1949	4,333.9	2,504.1	1,733.9
1950	3,216.8	3,091.9	804.1

The quantities of tin-plate and oil shown in table II are those which were officially allocated; they are larger than those actually delivered.

Of course, only olive oil is used in Spain where excellent refineries and neutralization plants exist. Canners require oils with a low acid content (.15 - .25 % of oleic acid; iodine value 82, approximately).

The vinegar used in the industry must be wine vinegar.

TABLE II. RAW MATERIALS CONSUMED			
Year	Fresh fish	Oil	Tin-plate
	Metric tons		
1949	77,795.3	5,294.6	4,973.3
1950	107,633.8	6,029.4	5.784.2

We shall now mention, in summarized form, a few interesting aspects of the Spanish food processing industry.

II. PRESERVED FISH

In view of the continual crisis (the actual causes of which are unknown) affecting sardine fishing, the fish processing industry which was basically concerned with sardine canning, transformed its activity so as to deal with other species. This evolution brought about a large increase in the number of products prepared. The new varieties of preserved fish find a ready sale, especially on the domestic market.

Many studies have been, and are still being made on the composition of fresh fish (1).

The 275 fish preserving factories existing in Spain employ 13 to 14,000 workers. They are distributed follows :

Bay of Biscay region	70
Atlantic or Northeastern region (Galicia)	140
Southern Atlantic region	30
Mediterranean region	25
Canary Islands	10

Factories are being set up in the Spanish possessions in Africa, with Government help. Two of these are floating factories, with the African waters as their field of operations.

If account is taken of curing, smoking, pickling and other plants, the number of factories amounts to 1200.

TABLE III. PRODUCTION - TOTAL AND ITEMIZED					
Year	Total production	Cured products	Products preserved in oil	Pickled products	Miscellaneous preparation
			Metric tons		
1949	56,410.6	19,631,1	19,799.6	13,622.7	3,357.2
1950	61,775.1	27,066.8	21,709.5	10,428.3	2,570.5

III. CANS AND TIN-PLATE (2)

A characteristic of the Spanish industry is that almost all canneries, with the exception of those of little importance, have their own workshops for the production of cans; this gives rise to a great variety of can sizes.

Liquid seam compounds, of domestic manufacture, are beginning to be used by way of trial.

Domestic tin-plate production is far from sufficient as it only covers 10 to 15% of our requirements. It consists entirely of hot tinned plate with an average coating 1.6 lb/b.b.

In 1950, 1635 metric tons of tin ore were processed in Spain, against 1102 in 1949.

Supplies of imported tin were less, i.e., about 40 tons of ingots in 1950.

IV. EQUIPMENT

The industry has become independant as far as current equipment is concerned; exports have even been made, especially to Spanish-American countries.

NOTA : Figures between ( ) refer to Bibliography, p. XI - 3.

The following improvements are worthy of mention : electric heating has entirely superseded producer gas in soldering machines; automatic feeding devices for double seamers with volumetric distribution of oil into cans, and appropriate for ant size of cans and especially for erctangular cans, have been developed; circular lid soldering machines with automatic feed and discharge, and air-cooling have been manufactured and also automatic beheading and gutting machines for horse mackerel.

Although the improvements and new machines described above are of great interest; it is above all in handling and cooking the fish that new methods have been applied, which by reason of their excellent results are worthy of description.

Evisceration and brining troughs

These are protected by several Spanish and foreign patents taken out by the Massò Bros. Co. In short, without mentioning the details by which they differ from one another, these troughs are of variable length (20 to 50 meters) and are divided into two parts : one for receiving the fish, the other for washing and subsequently brining. The advantage of this system is obvious as it allows of a 15 % to 20 % saving in labour, due to the fact that the workers (most of whom are women) carry out the entire process without changing place. The viscera fall into a third narrower trough placed immediately below the workwomen's hands, in this the viscera are carried away automatically in a continuous stream of water. The fish is brined automatically in a brine of variable concentration. As the fish is subjected to fewer handling operations than by other methods, its quality is improved. The possibility of recovering and distributing the brine more easily and more completely allows of a saving in salt.

Hot air cooking ovens

These are also covered by various patents belonging to the Massò Company, of Vigo; briefly, they consist of long tunnels (15 to 20 meters), open at each end, through which a counter-draught of hot air circulates. The fish is placed on grids, on a cable conveyor; its heating is gradual and it is kept in the oven for 20 to 40 minutes. The tunnel is fitted towards its middle with a gas evacuation in direct communication with the outside atmosphere. Photographs of these ovens and channels have been published (4). The ovens not only permit of effecting a saving in cost, but also of improving the quality of the fish.

Recently, heating by infra - red rays was applied to these tunnels and to others of the same kind; this is a great improvement by reason of the enormous possibilities existing in Spain for the production of electric power.

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XII. CANNED MEAT IN DENMARK

by C. S. LARSEN

Margarine Compagniet (Denmark)

After the war Denmark was in the lucky position to have retained her production capacity although renewals were badly needed. It was, however, possible just after the war has finished to set in with an export drive, the necessity of which one was aware of. First of all it was a question of recapturing markets which used to buy Danish canned meat and to develop these markets as well as finding new markets for Danish products of high quality.

Many factors added to hasten this development to a much higher degree than might have been expected. Maybe the most important factor since the war has been - and still is - the economically unfavourable trade agreements with England. Furthermore Denmark has been missing her old market for offal from the slaughter-houses during the first years after the war, as Germany was not able to take these products till the beginning of 1949. To secure a regulation of the market supply many cold stores were built after the war, partly based on private initiative and partly in connection with already existing co-operative slaughter-houses. Most of the privately owned canning factories already in use enlarged their production capacity very considerably whereas only a few new firms were started. The individual slaughter-houses - both private and co-operative - built to a great extent canning factories in connection with the slaughter-house for utilization of the excess production, a development steadily increased and which recently has resulted in a number of slaughter-houses in Jutland having arranged to build a big co-operative canning factory in Brabrand near Arhus.

During the first postwar years the government has tried to encourage the export of Danish canned meat as much as possible, partly by maintaining a thorough rationing of meat in the first years after the war and partly by forbidding the sale of canned meat on the home market.

A constant difficulty for the Danish meat canning industry has been the question of procuring the necessary tinplate as it very soon proved to be almost impossible on the world market to sell canned meat in for instance aluminium cans which at a time was easier available than tinplate. The political crisis - and the Korea-war not least - has made the tin situation further difficult, and to-day Denmark is in the situation that rather considerable amounts of cans form Germany have had to be imported owing to too small allocations of tinplate.

In outline one must say, however, that the Danish meat canning industry to a great extent has been able to secure a position on the world market, especially in South America, England, the Mediterranean countries, and last but not least in U.S.A. The reason for this is to be found in clever merchantship, initiative, and a well equipped production apparatus, and a staff of employees and workers of a high standard.

The greatest development in the Danish meat canning industry has taken place in the production of canned ham. Before the monetary devaluation in 1949 the greatest part of our export of this article was sold to South America and the Mediterranean countries. The devaluation made it possible, however, to export Danish canned hams to U.S.A. in a steadily growing amount. This was also favoured by the fact that Poland no longer sold hams to U.S.A. Great expenses have been connected with introducing Danish hams into the American market. Furthermore the production of American style-ham involved a change in the production methods and an increase in production capacity. First of all the Americans demand a very lean ham with no rind, hardly any fat, and with a very low percentage of shrinkage. They also demand uniformity and high quality. It has been necessary to use arterial curing of the hams in connection with a somewhat changed method of curing. The times of cooking and the cooking temperatures for the packed can differ also very much from what usually was used in the Danish factories. During the last years more than 5 complete ham canning factories have been built which all to them are equipped with the most modern apparatus, such as arterial curing, saltinjection percentage scale of American origin, ham press of Danish manufacture which presses the ham into the can, a special seaming machine of German construction, dip soldering table and evacuating soldering apparatus as well as cooking aggregates. On the most modern factories a special type of pressure retort with a special air pocket regulation and usable for a pressure of up to 4 ato. is used for the cooking.

By private arrangement within the industry itself a controlling institution has been founded which controls all goods made for export from the factories - canned hams included - and which has the authority to condemn a shipment intended for export. This institute has added very much to raise the standard and, no doubt, this important factor is partly responsible for the rapid and immense growth of the export of canned meat. Of other important export goods canned picnic hams may be mentioned. These hams are packed in "pear shaped" cans just as the hams.

During the first years after the war a considerable export of pork in broth took place - for instance to England. This product has now been replaced by luncheon-meat, which is of less calorific value. Of further canned meat products liver paste, Vienna-sausages, tongues, jellied veal, and some kinds of canned beef, brawn and so on can be mentioned. Furthermore a considerable export of Dauerwurst has taken place, as for instance England has imported considerable quantities of Salamy-sausages, and other countries sausages of Salametti, Pure Pork, and Mortadeltypes.

In the years just after the war the mechanical development in the Danish meat canning factories has been characterized by the wish of getting the most adequate machines both with regard to the production as to the hygiene. You will, therefore, in most places find stainless steel used for tables, trolleys, cookers,

and containers. The greater factories have to a high degree imported Swedish meat treatment machines such as self-feeding meat grinders and self-emptying bowl cutters. The different types of mixing machines and sausage fillers (air- or hydraulic pressure) are usually of Danish manufacture just as the Roll-bowl-cutter used for the salami production. The sausage filler is used very often as a canfilling apparatus and the filled cans are weighed and transported to the seaming machines on conveyor belts made of stainless steel installed in the tables. During the first years after the war a great number of full-automatic seaming machines were imported from Belgium, but now these are being replaced by German machines. During the last few years there has been a tendency towards using vacuum seaming machines, but apart from a new machine of Swiss construction it seems like the European manufacturers of this type of machine have not yet found the right solution suitable for the capacity of the Western European factories. The capacity of the American vacuum seaming machine is usually much too high for the European factories, but the development will undoubtedly go this way as the exhausting process never has been able to gain ground in the meat canning industry. Lately vacuum mixers have been taken into use here as in U.S.A. Their greatest importance is no doubt at the production of Vienna-sausages and minced goods such as luncheon-meat, where inevitably an essential amount of air is whipped into the meat during the chopping and even a vacuum seaming machine has difficulty in removing this air. For the sterilisation a cooking apparatus of the pressure cooling retort type is used in most cases. No Danish factory has so great a capacity that the purchase of a continuous retort at the present technical state is justified. For cleansing of the sterilized cans can washing machines of various constructions are used and in some cases they are provided with a drying zone so that the cans can be transported directly to the labelling machine.

At last it can be mentioned that a very considerable work has been done to raise the hygienic standard in the meat canning industry by the Ministry of Agriculture in connection with the industry itself. All greater slaughter-houses and canning factories have a permanent veterinarian who is appointed by the Ministry of Agriculture but is paid by the factories, and he is responsible to the authorities for the hygienic state of the industry being so high that products from the factory can be exported without any risk provided that the quality claims are complied with. The Danish co-operative slaughter-houses have during the war seen the necessity of having a suitable experimental station where experiments on a large working scale can be made for the benefit of the slaughter-houses all over the country and at present a big experimental slaughter-house in Esbjerg is being built. In connection with this slaughter-house both cold-stores and freezing plant as well as a canning factory is built. Besides this a research laboratory has been established in Copenhagen under the direction of a professor in biochemical chemistry. This laboratory shall attend to the demand for laboratory research work of the canning industry. On the whole the development has been characterized by a growing understanding of the necessity of employing technically and scientifically educated employees. The Danish meat canning industry has undergone an immense development which in many cases has resulted in a ten-fold bigger export capacity and the Danish canning industry is of the general opinion that the gained position can be hold and even be further developed.

XIII. TECHNOLOGICAL ADVANCEMENT IN FOOD PROCESSING METHODS IN THE CANNING INDUSTRY IN U. S. A. IN 1940-1950

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Technological advances of major import in any field of industry are accomplished with annoying slowness. Years and even decades often measure the progress of mental and experimental activity before the development of an idea brings one to a goal which is marked by the successful commercial use of a new process or a new machine.

This seems to be an especially fitting time to make a study of commercial applications of new processes and machines in the canning industry during the most recently closed decade because that period has been marked by the introduction into commercial use of an unusually interesting and significant group of technological and engineering innovations. Some of these represent completion of research and development programs that have been in progress since soon after the time of the first activity in the canning industry deserving to be graced by the name of technological experimentation. This is only one reason why the writer was pleased when he was honored by the chairman of the committee which arranged the program for this memorable meeting with an invitation to prepare a paper on the technical developments in processing having taken place during the last 10 to 12 years.

I. PRODUCTS AND TECHNICS

No one who is versed in canning lore is surprised to be told that practically all technological advances in the canning industry are associated with efforts to produce preserved food having better quality than that which has been produced by conventional canning methods. The period since the outbreak of World War II has been an especially fruitful period in the introduction into commercial use of new processes which accomplish this purpose.

For classification, to assist in making a logical presentation, we shall divide the preservation processes into three categories or types, described briefly as follows :

1. High temperature short time sterilizing processes;
2. Sterilizing processes employing temperature and time in the intermediate range and employing a modified technic during processing.
3. Preservation processes employing modified technic in preparation of a food product for processing, followed by use of conventional procedure in processing.

In addition to processes of the above three types, which already are in commercial use, a few preservation processes will be briefly described which, to the best of our knowledge, have not yet reached the stage of commercial readiness.

1. High-temperature short-time sterilizing processes

a) HCF process

This process was named by putting together the initial letters of the three words, "heat-cool-fill", which describe the procedure followed in the process. BALL (7) describes this process by stating that it " provides for the operations of sterilizing empty containers, sterilizing and cooling covers for the containers, sterilizing a food material in bulk, putting the sterilized food into the sterilized containers, and applying the sterilized covers to seal the containers. All operations in handling the sterilized objects until after the containers are sealed are performed under aseptic conditions, which are maintained in closed chambers by the presence of steam under a pressure greater than that of the outside atmosphere ".

In practice, sterilization has been accomplished entirely by heat through indirect use of saturated steam in a heat exchanger through which the product flows continuously; thereafter, the product is cooled while flowing through a similar heat exchanger in which water is the cooling medium. If the cooling prior to filling is not all that is required for the final product, a final stage of cooling is carried out on the sealed containers.

The aseptic conditions in which the containers are filled and sealed are created by maintaining a positive pressure of about 2 - 3 p.s.i.g. by means of either saturated steam alone or a mixture of saturated steam and sterile gas, which fills a chamber in which the filling and sealing are carried out. Containers and covers, previously sterilized with saturated steam, are introduced into the chamber through rotary pocket valves, all surfaces of which are kept continuously sterile by protecting them from contact with outside atmosphere. The walls of the filling sealing enclosure have substantial strength to make possible the sterilization of the interior of the enclosure with steam under pressure of 20 p.s.i.g. or more prior to operation of the equipment.

The objective in using this process, of course, is to realize the great improvement in quality of canned product which is possible with very short sterilizing process. About 10 years ago the HCF process, sponsored by the American Company went into commercial use in processing a chocolate flavored milk beverage and the process has been used continuously on that product. The sterilizing process is at a temperature of 280° - 290°F (138° - 143,5°C) for a period of about one minute. A most desirable quality is obtained in a product which is rendered unacceptable when sterilized in the conventional manner. The process is carried out under the protection of U.S. Patent 2,029,303 (5). A special treatment of the cocoa raw material was found to be necessary in order to render the cocoa free from viable spore of microorganisms which fortify themselves in various constituents of cocoa before the product is formulated. This treatment is covered by U.S. Patent 2,396,265 (41). A description of the equipment used in processing the chocolate flavored drink is contained in an article entitled "Sterilization by heat" by JACKSON and BENJAMIN (42).

In 1949, additional equipment was installed to double the producing capacity of this operation. Inasmuch as this operation has been commercially successful, a curiosity is naturally aroused in the minds of those who are interested in this sort of process as to why the use of the HCF process has not expended to include other products. With experimental equipment, during the development of this processing procedure, demonstrations were made of vastly superior quality in dairy products, pureed vegetables, cream style corn, chop suey, and other products when sterilized and canned by the HCF Process as compared to the quality of these same products canned and sterilized by conventional methods.

A commercial operation, which continued for only a few months, was carried out in 1948 on strained vegetables, which were packed in cans of about one pound capacity. This operation was successful mechanically except that the heat exchanger used for sterilizing the product was reported not to have given entirely satisfactory results and it was said that this difficulty, combined with a certain difficulty encountered in attempting to establish a market for pureed vegetables in a field other than that of baby foods, caused suspension of the operation. However that may be, it seems to be generally believed that the requirement of highly specialized equipment for filling and sealing the containers, which is quite costly is the main factor that has retarded expansion in the use of the HCF process.

NOTA : Figures between ( ) refer to Bibliography, p. XIII - 19.

b) Avoset process

The process, which we shall designate by the name "Avoset", went into use on a physically stabilized cream product, called "Avoset" in about 1942. This process resembles the HCF process in principle but in operation it differs in that there is no positive control of atmospheric conditions surrounding the filling and closing operations. These operations are carried out in an air conditioned room at atmospheric pressure, the atmosphere of which has direct contact with the outside atmosphere at an opening in the wall of the room through which the containers, after sealing, are discharged on a conveyor into the outside atmosphere. Moving parts of the conveyor may carry some bacteria into the filling and sealing room but an outward flow of air from this room through the opening is maintained, which protects against entrance of contaminated air from outside the room.

Sterilization of the product is accomplished in heating and cooling tanks which are part of a sterilizing system originated by George GRINDROD. In this system, the food is heated by saturated steam in high velocity jets which are directed into the product. The steam injectors usually operate at pressure between 35 and 55 p.s.i.g. within vertical cylindrical chambers, through which the product is forced continuously by means of pumps. After the product attains its maximum sterilizing temperature (usually between 260°F (127°C) and 280°F. (138°C.)), it is held without cooling for a sufficient length of time to complete the sterilization of the product. When sterilization is completed, the product is forced by pressure into an evaporator where the product is condensed to the desired proportions and is cooled to the proper temperature for homogenization. After being homogenized, the product is filtered and cooling is then completed in a heat exchange type of cooler, from which it is pumped into holding tanks, vents of which are protected by ultraviolet lamps. From the holding tank, the product flows by gravity to the filler, the atmosphere around which is air that has been treated to remove bacteria and which is further protected by means of ultra violet lamps. The Grindrod sterilization system is described in a number of U.S. Patents (28 - 30).

In the Avoset operation, for a number of years, containers were sterilized by means of saturated steam in retorts, mounted so as to extend through the wall of the filling and closing room. Each end of the retort was fitted with a door. The retort was loaded from the outside and the sterilized containers were discharged inside the room by opening the inside end of the retort. This method of sterilizing containers was discarded in favor of presently used hot air sterilization of continuously moving containers which are discharged from the continuous sterilizer into the filling and closing room. Since glass containers are used, it is unnecessary to limit the maximum temperature of the sterilizing air to a temperature below that at which solder on cans would be softened.

Closures for the containers are sterilized in retorts in a manner like that described above for the containers. Operation is carried on at a rate of from 75 to 100 8-ounce bottles per minute. This operation has been successful in producing commercially a cream product of outstanding organoleptic quality and this has led to plans to establish a second plant. In this plant, it is planned to supplement an 8-ounce glass line with a new and different processing system using cans, known as the Martin process, which we shall next describe.

c) Martin process

The development of the Martin process was begun during World War II and the first commercial installation, involving a unit with a production capacity of 42 15-ounce cans per minute, was put into operation in January, 1951, processing soup (39, 46).

The product is sterilized and cooled in the same manner as in the HCF process; however, in sterilization of containers and in filling and sealing, the Martin process differs from the HCF process in that the former employs superheated steam at atmospheric pressure instead of saturated steam under pressure greater than atmospheric pressure. MARTIN (50) describes the fundamental steps of his process in these words :

" The canning procedure consists of four seperate operations which are carried out simultaneously in a closed inter-connected system as a continuous process. The operations are :

1) sterilization of the product under pressure at a high temperature by quickly heating, holding, and cooling it in a continuous flow-type pressure cooker;

2) sterilization of the containers and covers with super-heated steam or other hot gas;

3) filling of the cold sterile product into the sterile containers;

and 4) aseptic sealing of the containers with sterile covers.

The various operations are synchronized mechanically so that the raw product, containers, covers, and finished canned product move through the system without interruption. The product is maintained under pressure throughout the sterilization process, and the filling and sealing operations are carried out in an atmosphere of superheated steam or other sterile inert gas."

In accordance with customary procedure with all processes of this general type, before the process is operated, all surfaces of equipment, from which bacterial contamination might enter the food, are sterilized. The interior of the product heater is sterilized with either water or saturated steam at a temperature which is usually above 260°F (127°C) and the aseptic canning equipment, as well as the sterilizers for containers and container closures, are simultaneously sterilized with superheated steam or other gas at 400 - 400°F (204.5° - 315.5°C).

The Martin process has been designed for use with liquid products only. The product heater is of the tubular type and the filler, as described by MARTIN (50), "consists of a rectangular enclosure through which the cans are conveyed continuously in a straight line beneath a slit - type filling nozzle." MARTIN reports that "spillage is almost completely eliminated by the overlapping flanges of the cans as they pass beneath the filler slit." Figure I (p. 4) shows a factory layout for the Martin system.

Information available on the time and temperature conditions necessary for sterilizing empty containers by means of saturated steam was extensive even before the Martin process was developed. This information, however, could not be applied to sterilization by means of superheated steam; therefore, to ascertain the combination of time and temperature necessary when superheated steam is used, Dr. MARTIN conducted extensive experimental packing tests, in which cans and covers were inoculated with spore suspensions of Organism

PA-3679 and Flat Sour Organism 1518, supplied by the National Canners Association. He published data resulting from these tests (449), also a list of combinations of time and temperature which were found to be effective (50).

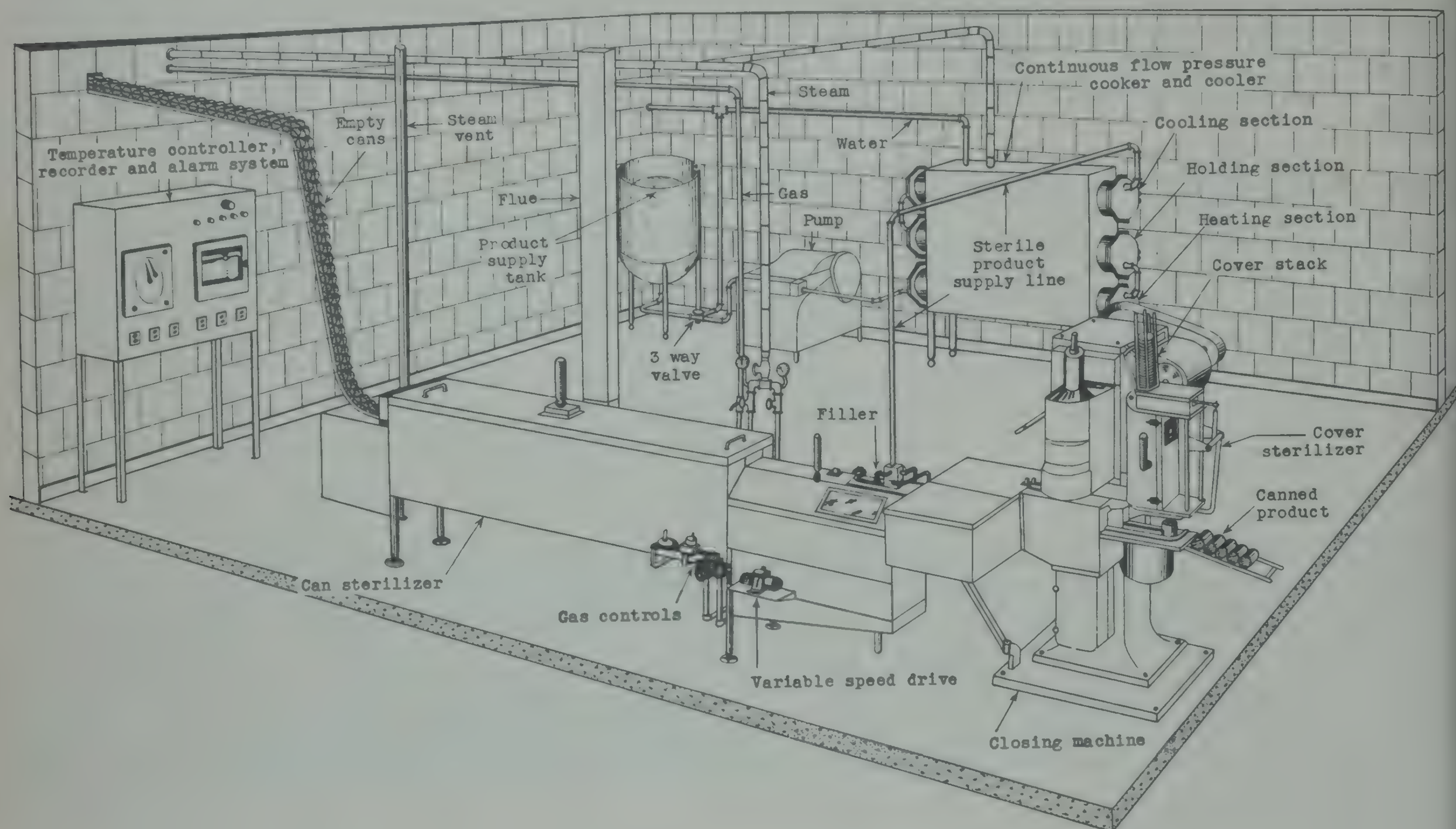


Fig. 1. Factory layout for Martin aseptic canning system. James Dole Engineering Company.

With the use of pilot equipment, the Martin process has been shown to be capable of producing sterilized food of 32 different varieties, having much better flavor and color than control samples processed by conventional methods.

d) Smith-Ball process

The most recent addition to the list of high temperature - short time processes being used commercially is the Smith-Ball process.

In general pattern of operation, this process is similar to that of the HCF, Avoset, and Martin processes; like each of the latter three processes, however, the Smith-Ball process has several unique features.

The product in bulk form, is pre-heated to a high temperature, 280°F - 300°F (138°C - 149°C) for sterilization before canning but, unlike the operation in the three processes previously described, the food is cooled to only about 250°F - 255°F (121°C - 124°C) before filling into the containers. Since the first unit for carrying out this process was designed for chop suey, a product containing solids in particulate form, the product heater differs greatly in design from the liquid heaters which have been used with the HCF, Avoset, and Martin processes.

A flow diagram of this processing system in shown in figure 2.

e) Presterilizing process for tomato juice

Studies of Bacillus thermoacidurans, the usual causative micro-organism of flat sour spoilage in tomato juice, during the 1930's, led to the development of a presterilizing technic through which the sterilization of tomato juice could be assured when the bacterial contamination of the raw material is within reasonable limits. A short heat treatment at a temperature in the vicinity of 250° - 270°F (121°-132°C) is given the juice prior to filling into containers. This heat treatment is designed to destroy heat resistant acid tolerant bacterial spores in the juice before packing. The treatment is applied while the juice is in continuous flow through a heat exchange apparatus of either plate or coil or straight tubular design.

The heating of the juice is as rapid as possible but the rate of heating varies with the design of the heat exchanger. Thus, in selecting the design of the heat exchanger, several factors must be considered, viz :

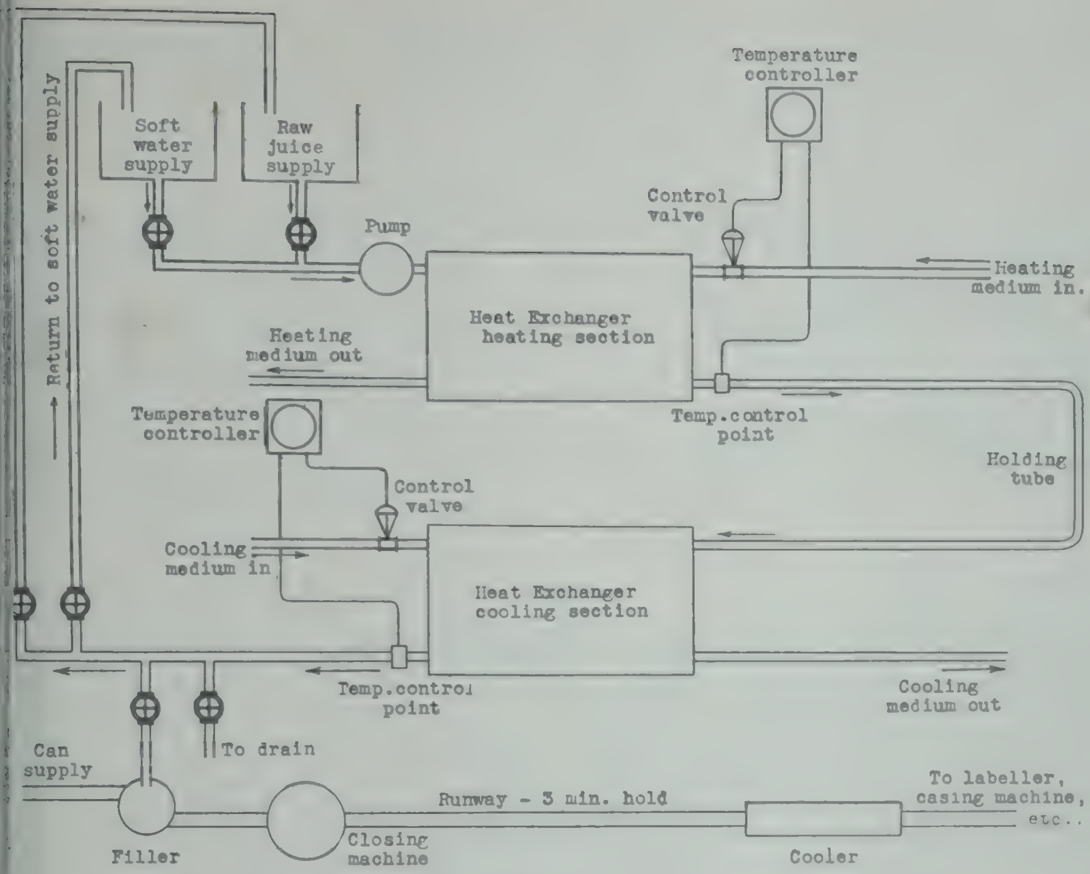


Fig. 2. Flow diagram for presterilization of tomato-juice. American Can Company.

1) the distance the heat must flow through the product;

2) the conveyance of heat by currents within the food, produced by turbulence;

3) turbulence which may affect surface film formation.

These factors determine the rate at which the tomato juice will be heated; thus, to a large extent, they hold the answer to the question as to the overall advantages, from both quality and cost standpoints, of the presterilization procedure over other procedures involving sterilization in sealed containers as that of end-over-end rotation of the containers. This question deserves consideration by anyone planning to equip for sterilizing tomato juice. An important advantage in sterilizing the juice in sealed containers is that this procedure obviates the possibility of contamination of the juice with resistant spoilage microorganisms during the filling operation. Should such contamination take place when the presterilization procedure is being followed, the canned juice may spoil because, under this procedure, the juice undergoes only a mild heat treatment after the container is sealed.

Factor No. 1 mentioned above is obtained in the presterilization process by making the channel through which the juices flows between heated surfaces very thin nd is obtained in the process of sterilizing in the sealed container by using containers of small size.

Factor No. 2, viz., turbulence, is obtained in the presterilization process by making variations in he cross-sectional shape of the channel through which the juice flows during heating and by employing a igh velocity of flow of the juice through the channel during heating and can be obtained in the process of terilizing in the sealed container by using an optimum speed of rotation of the containers during heating nd by using the maximum permissible headspace in the container.

Factor No. 3, viz., reduction of surface film effect, is applicable only to the presterilization ethod. Advantage can be taken of it only by employing an extremely high velocity of flow of the juice through he channel during heating. Although the practical significance of the benefit obtainable through this factor ay be questioned, it is said that a tubular coil passing 1800 gallons of liquid per hour at a velocity of pproximately 2000 feet per minute has an overall heat transfer rate of 1200 b.t.u. per hour per square foot er degree F. mean temperature difference, which is twice as great as that claimed for other heat exchangers.

It is further claimed that, under this high turbulence, the temperature of juice can be raised from 00° to 300°F (38° - 149°C) in two seconds.

A flow diagram, fig. 2, indicates equipment used in presterilizing tomato juice.

SOGNEFEST and JACKSON (58) describe the presterilization procedure as follows :

" The commercial application of the presterilization method consists of heating the prepared juice
" rapidly and continuously to a temperature of 250°F to 280°F (121° - 138°C) depending somewhat upon the
" type of heat exchanger employed, and rapidly cooling to a temperature below the boiling point before filling.
" The juice is filled at a minimum temperature of 190°F (88°C) and held for 3 minutes before water cooling.
" The 'high-short' process is designed to destroy spores of heat-resistant, soil-borne microorganisms and
" the 'high' filling temperature and the short hold before water cooling serves to kill bacteria of low re-
" sistance that re-enter the product during filling.

....

" Care is exercised in sterilizing the entire equipment contacting the juice with water at around
" 240°F (115.5°C) for 10 minutes before admitting the sterile juice.

....

" If a 250°F (121°C) process is used, a holding time of 0.7 minute at 250°F has been suggested for
" sterilization with respect to B. thermoacidurans. This holding time is effected by connecting a pipe of
" sufficient capacity in the juice line between the heater and cooler. At 265° to 280°F (129,5° - 138°C)
" the entire process may be accomplished by bringing the temperature of the juice up to these temperatures.
" The temperature needed depends largely upon the particular rate at which the juice is heated and the par-
" ticular type of equipment used."

Certain historical facts bearing on the development of the presterilization procedure for tomato juice are quoted from SOGNEFEST and JACKSON (58).

" From many unpublished results on thermal death time tests employing the multiple tube technique, " practically all strains were destroyed at a sterilizing value corresponding to 0.7 minute at 250°F (121°C). " The choice of a sterilizing value equivalent to F_0 = 0.7 seemed to be a reasonable one for the commercial " application of the method since the maximum resistance seemed to be around this value. An equivalent boiling " water process for a No. 2 can of juice with an initial juice temperature of 170°F (77°C) would be about " 140 minutes at 212°F (100°C). Such a long cook would, of course, cause much quality deterioration, but it " clearly indicates the exceptionally high heat resistance of this spoilage organism.

" Since no loss in quality was found in the juice packed by the 'flash' sterilization procedure, which " later was termed the presterilization method, commercial installations employing this method were placed " in use during the 1941 canning season."

The rapid growth in acceptance of the method in the United States is shown by the fact that, during the 1945 season, approximately 50 presterilization units were in operation and the number has increased each year since 1945.

2. Sterilizing processes employing intermediate temperature and time and a modified technic in processing

a) Agitating vacuum process

One of the earliest processing improvements which came into major importance in the industry as a means of quality improvement was the " vacuum pack " process, which was introduced commercially in the late 1920's. This is a process in which foods of particulate type, such as whole kernel corn and peas, are packed with only a small quantity of free liquid in the can by sealing the can under high vacuum and then processing in the conventional manner. Within the last five years, substantial progress has been made in profiting from the advantage which can be gained by employing with vacuum packed products the principle of can agitation during the process to accelerate the heat penetration and thus make possible a reduction in processing time. ROBERTS and SOGNEFEST (57) published data from an extensive investigation, showing the magnitude of advantages that could be realized by applying the agitation principle as exemplified by cookers of various types. They stated that, during 1946, several canners utilized the agitating process for vacuum packed corn, to such extent as this use involved commercial operation. The 1946 activity apparently was concerned primarily with batchwise cookers which provide agitation by means of a revolving crate. Starting in 1944, however, experiments had been under way by the Green Giant Company on a can-rotation open type of continuous processing unit utilizing a high boiling point liquid as the heating medium. This unit, known as the Thermo-Roto machine, consists basically of a series of parallel rollers with centers so spaced as to accommodate cans of various sizes resting horizontally on the rollers in rows which are defined by the furrows between the rollers. The rows of cans are moved successively from one furrow to the next by means of pusher arms, one of which is located between each two adjacent rows of cans.

The series, or bed, of rollers is called a deck and, as the rows of cans move across the deck in successive steps from one furrow to the next, the cans are sprayed by the liquid heating medium. Cooling of the cans in water sprays is carried out by a similar procedure on a second deck. The hot deck holds about 50 cases of 307 - 306 cans.

During 1946, samples of corn were packed for quality tests and in 1947 the first commercial scale unit was operated on corn - on an experimental basis. Peas were processed in an experimental unit in 1947 but no improvement in quality was produced, as compared to that of regular still-cooked vacuum packed peas.

A pronounced improvement in quality of corn was obtained by processing in this machine, and, starting in 1948, a plant scale machine was operated on vacuum packed corn. Season's runs on corn were made again in 1949 and 1950.

Extensive experiments with vacuum packed peas in 307 - 306 cans in 1949 gave results which left much to be desired. It was difficult to produce a product having desirable texture without using a quantity of brine which was practically equivalent to that of brine packed peas.

The outlook for the application of this principle commercially in processing any product is not bright, due to two annoying difficulties which became apparent during the tests mentioned above. First, tests with various high boiling point liquids, including propylene glycol and a number of oils, led to an apparently well justified conclusion that presently known liquids are unsuitable for use as heating media, where the media, in spray form, are exposed to oxygen. All compounds used decompose to form insoluble tarry residues. In some cases, corrosive substances of low boiling point are produced in the decomposition. Corrosion of tin plate and difficulty in removing the decomposition products from the can surfaces are experienced and, because of the high rate of decomposition, the cost of materials is high. The substitution of immersion heating for spray heating might avoid the decomposition of the liquid but immersion was impracticable in the unit which was used in the tests because of temperature control complications. Another way to alleviate the decomposition might be to substitute inert atmosphere for air but this also would introduce serious mechanical complications.

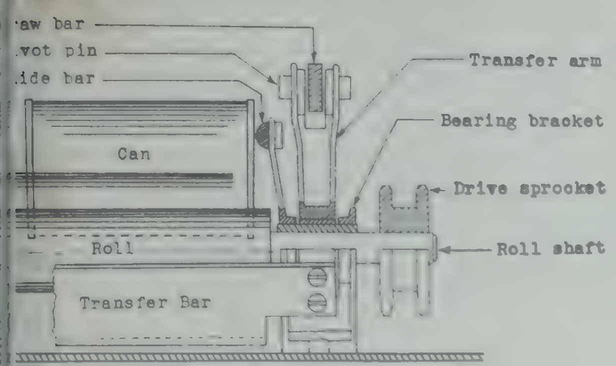
The second, and less serious, difficulty arises from inadequate mechanical strength in standard cans to withstand the high pressure which is generated within the cans, counteracted externally only by normal atmospheric pressure. While this situation does introduce a problem, buckles in the can ends can be prevented by the use of abnormally heavy and highly tempered plate, to which assitance may be given by the use of special end profiles.

The above conclusions were reached after extensive seasons' runs by the Green Giant Company in 1948, '49, and '50. Diagrammatic views of mechanical features of the Thermo-Roto are shown in figures 3, 4, and 5.

b) Continuous cooker of reel and spiral type

For many years, brine packed whole kernel corn has been processed in a continuous cooker of the

ype in which the cans are conveyed in a spiral path on the periphery of a rotating reel. In 1950, for the irst time in commercial operation, vacuum packed corn in 307 - 306 cans was processed in such a cooker by e Green Giant Company. The results are reported to have been quite satisfactory from all standpoints. Tempe- atures of not less than 260°F (127°C) were employed in the cooker. The operation was repeated in 1951.



ig. 3. Agitating vacuum process. Thermo-Roto machine. Diagrammatic view of one end of a roller and a transfer bar. Chain Belt Company.

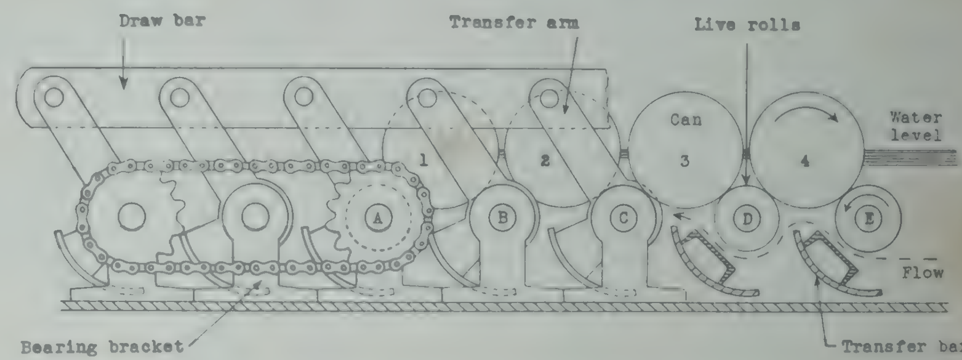


Fig. 4. Agitating vacuum process. Thermo-Roto machine. Diagrammatic view from side of machine, showing end bearings for a series of rollers, transfer bars at rest during rolling period, and draw bar by means of which transfer bars are operated. Chain Belt Company.

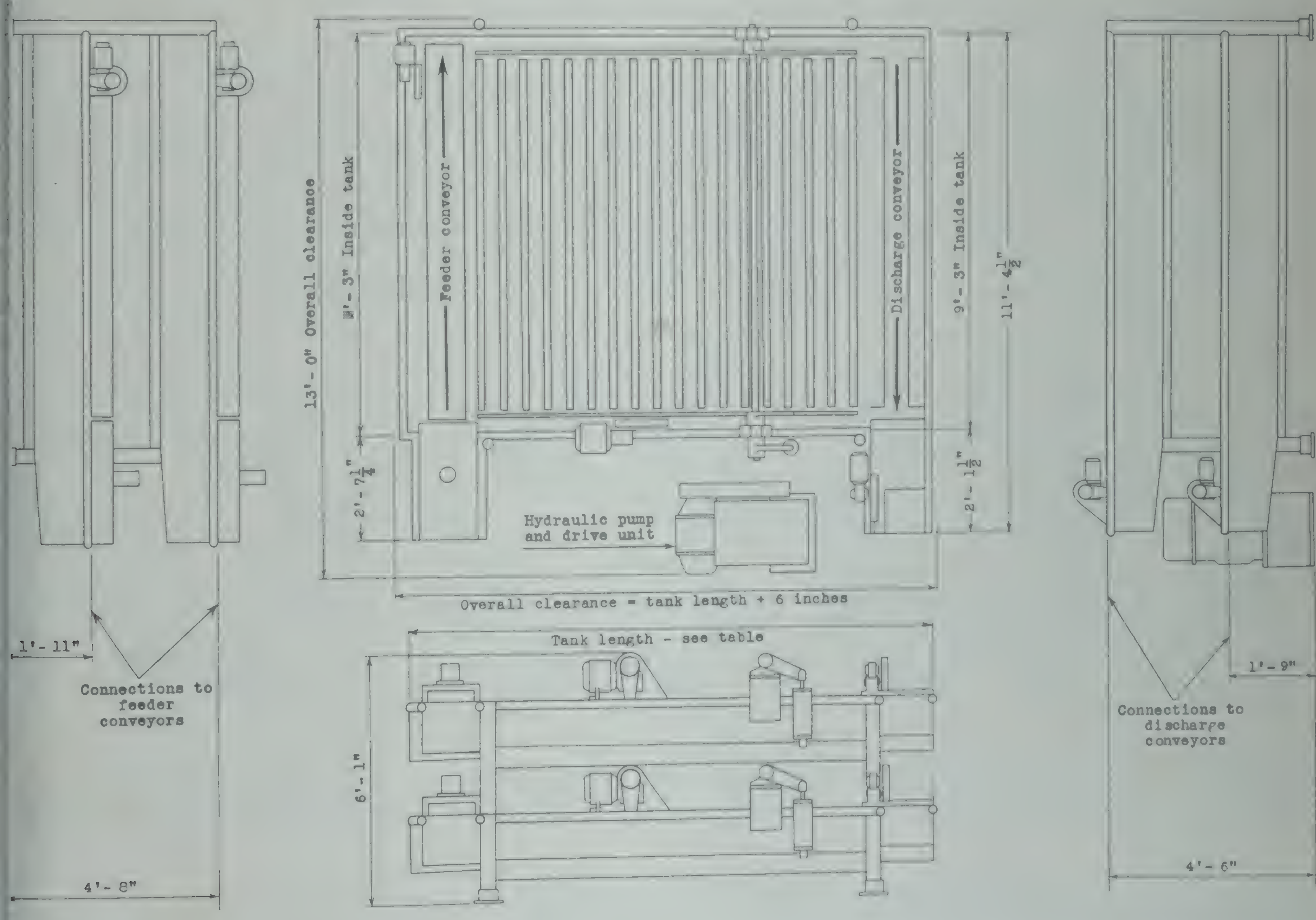


Fig. 5. Agitating vacuum process. Diagrammatic plan and elevations of double deck Thermo-Roto. Chain Belt Company.

c) Principle involved in processing vacuum packed food by agitation

Vacuum packed foods, such as corn, are slightly compressed within the can when the can is sealed;

therefore, in the early part of the process, the solid pieces of the food do not move about when the can is agitated. The acceleration of the heat transmission is accomplished only through the movement of the brine through the interstices among the solid pieces (kernels in the case of corn). It is apparent that, under this situation, a medium quantity of brine would give more rapid transmission of heat than either a very small quantity of brine or sufficient brine to fill all interstices of the product. The latter fact has been verified by heat transmission studies in corn and peas, which showed the optimum amount of brine to be approximately two ounces per 307 - 306 can. Less than two ounces was not enough to carry heat to the center of the can at the maximum possible rate; brine in greater amount than approximately two ounces is less active in moving about in the rotating can than is the optimum amount of two ounces. In addition, the heating of the can contents is retarded somewhat by the presence of a greater quantity of brine because of the heat required to raise the temperature of the excess brine.

Experience has shown that conventional 307- 306 cans containing vacuum packed products sealed under vacuum of at least 20 inches will panel if subjected abruptly to the optimum processing pressure of a continuous cooker for these products. For this reason, it is customary to pass the cans through a preheater at moderate temperature and pressure before running them into the sterilizing cooker. A preheat treatment of two or three minutes at approximately 220°F has been found sufficient to produce an internal pressure which will prevent panelling of the cans upon entering a cooker operating at 20 pounds pressure.

d) Sterilmatic process for cream style corn

Owing to the importance of sweet corn in the American canned foods industry, cream style corn was one of the first products to be studied in the endeavor to sterilize canned foods in a continuous manner. The first tests were made in cookers in which the cans were rotated at a sufficient speed to produce movement of the product within the container. The first commercial scale continuous cooker to be tried was that in which the cans are conveyed in a helical path on a rotating reel, in which the cans roll on the spiral track as they travel along the lower part of the periphery with each turn of the reel. The process was not successful because agitation of cream style corn during heat processing for sterilization produces coagulation of the creamy portion of the product. Being a complex colloidal system, this creamy portion is quite sensitive to agitation under heat.

Starting with tests on the "Johnson" cooker in Hoopeston, Illinois in 1920, in which tests the writer participated, attempts were made to produce a practical continuous cooker in which cream style corn could be sterilized without curdling. Experimental results with the "Johnson" cooker were not satisfactory. Extensive experiments were conducted to study the effects of materials which might give physical stability, including various starches and gums. A "non-agitating" type of the helical track, reel type cooker was built, in which the rotation of containers about their own axes was prevented. Agitation increased the rate of heating in the can; without agitation, the rate of heating was very low and the process required was long. The problem, therefore, involved a choice between acceptance of curdling which was obtained with an agitating short process and the higher cost and lower quality associated with a non-agitating, long, process. The conclusion reached was that any continuous cooker which gave sufficiently gentle treatment to the product to avoid curdling was too costly to use because of the capacity required in order to give a process of the necessary length.

The problem was never discarded in despair and the problem was attacked intermittently over a period of about 30 years; finally, success was announced in 1950. WILBUR (59) announced the development by Frank HICKEY and R.L. WHITMORE of a process in which a special starch is used as a stabilizer to prevent coagulation when heat penetration into the product is accelerated by agitation during the process. He states, "a corn starch has been produced which meets rigid bacteriological standards and which is effective in quantities smaller than those commonly used in current practice. This starch is such an effective anti-coagulant that by its use alone curdling of cream style corn can be suppressed". An indication as to the nature of this starch may be contained in the following extracts from WILBUR's description of the nature of curdling. Referring to the curds from the cream style matrix of corn, the author stated, " In the yellow varieties of " sweet corn, those curds are found to be largely protein associated with corn oil and pigment .... It has " been shown that these curd proteins are derived from the milk and the fresh endosperm .... Endosperm " milk, when freshly expressed from the raw kernel, contains elements of the coagulum, together with starch " grains and other solubles and dispersions .... A typical Golden Cross Bantam variety, containing about " 70 percent moisture, shows on the original wet basis about 1.4 percent total N, and about 0.14 soluble N. " The total starch was about 7 percent and the "free starch" about 4 1/2 percent. The free starch referred " to is starch floating freely in the fluid dispersion, and not associated with particles of material size. It " appears that the soluble nitrogen and the free starch play a larger, if not completely understood, role in " curdling and consistency problems than the total nitrogen and total starch .... There appears to be " strong support for the view that the heat coagulation of the soluble protein fraction is the cause of curdling " and that agitation causes agglutination, thus interfering with the formation of a smooth gel."

The consistency of the product during processing and the amount of headspace in the container are necessarily controlled rigorously to ensure successful operation of this process.

The short process of 16 minutes at 275°F which is made possible by mechanically induced convection gives a product of markedly better color and flavor than that obtained from the conventional method of processing.

Specifications for 303 - 406 cans of cream style corn to be sterilized by the "Sterilmatic" process are as follows : (+)

minimum gross headspace	1/4"
minimum initial temperature	180°F
product consistency (F.M.C. consistometer) ...	max. 65
cooker speed (degree of agitation)	260 c.p.m.
process	16 minutes at 275°F.

(+) Personal communication from P.C. WILBUR.

e) Increase in flexibility of continuous cooker

The usefulness of the continuous cooker of reel and spiral type has been materially expanded by the ntroduction, within the past two years, of improvements which make a single cooker capable of handling cans which vary substantially in both diameter and length. By only a valve change, a given cooker is made capable f running cans of 307 diameter, varying in length from 306 to 409, cans of 300 diameter, varying in length rom 400 to 409, or cans of any size intermediate to those named. In fact, cans of both 307 and 303 diameters, in certain lengths, can now be handled without a valve change. The latter possibility gives added mportance to a newly developed feature which permits the running of two grades of product simultaneously while keeping them segregated. A special feeding mechanism places alternate cans into alternate pockets of he valve and, at the discharge valve, the cans are automatically separated and the cans of one grade are put onto one runway while those of the other grade are put onto a second runway.

Another recent improvement, consisting of a positive "paddle" discharge incorporated into the valve, combined with a turret transfer between the units of the line (preheater, cooker, and cooler), makes it possible to handle cans of large size at a very high rate. This is accomplished by allowing more time to effect he transfer, thus reducing the acceleration necessary on the can. This improvement furthermore prevents transfer impact on the can seams - another very important accomplishment.

f) End over end rotation of containers

During the past five years, intensive studies were made of the nature of the turbulence produced in a liquiform product in a container while in end-over-end rotation. Such rotation is effective in accelerating the rise of temperature of the entire contents of the containers to a greater degree than any other type of container movement. When the axis of rotation is located externally to the containers, however, the speed of rotation must be so controlled that it will not exceed that at which the composite force of the centrifugal and gravity effects, by producing stagnation in the product, begin to increase the time required to raise the temperature of the entire contents.

CLIFCORN et al (16), in describing a study by one laboratory of the effects upon induced currents within the container of balancing the centrifugal and gravitational forces acting upon the product during rotation of the containers, state :

" It was found that by selecting the proper speed the headspace volume could be made to pass through " the liquid at various levels and when the speed is such that the centrifugal force equals the weight of " the liquid contents, the headspace volume passes approximately through the center of the can. This was " also found experimentally to give maximum turbulence within the can contents, resulting in the greatest " rate of heat penetration.

" This was considered important because it showed that for the maximum rate of heat penetration, the " headspace volume must be made to pass through the approximate center of the can."

Figure 9 illustrates diagrammatically the movement of the headspace volume in a liquid product when revolution of the can is at "optimum" speed, as compared to the movement shown in figure 6 for low speed and in figure 7 for high speed revolution.

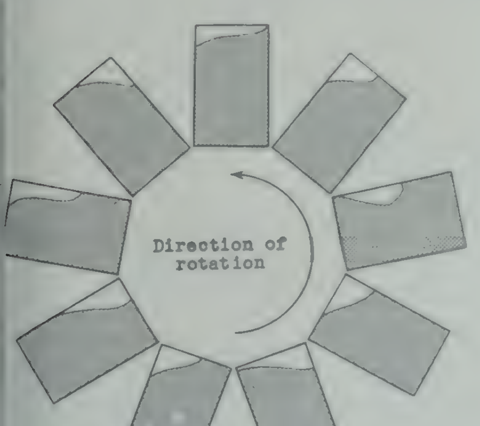


Fig. 6. End over end rotation. Mobility produced at low rotation speed. Continental Can Company.

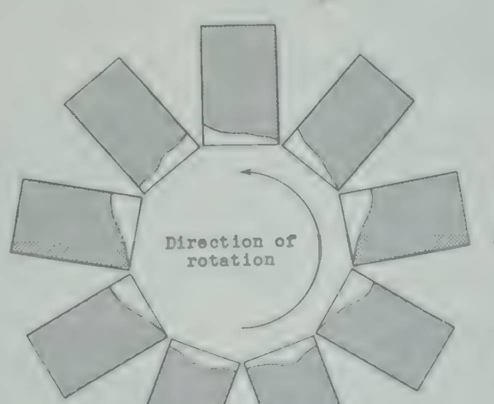
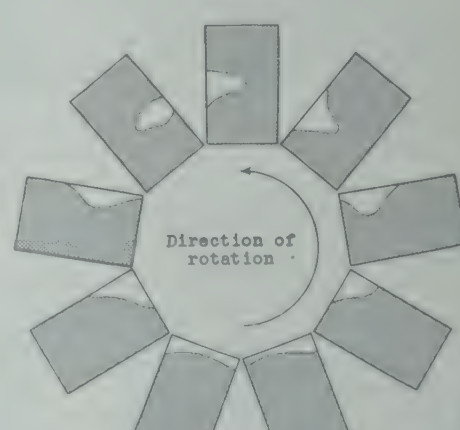
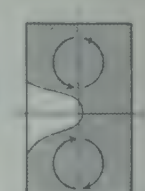


Fig. 7. End over end rotation. Mobility produced at high rotation speed. Continental Can Company.





Turbulence created when void space traverses through center of contents

Fig. 8. End over end rotation. Mobility produced at optimum rotation speed. Continental Can Company.

The above conclusion of CLIFCORN et al, was not confirmed by the writer in a similar study. Viscosity was found to have a greater effect upon the speed of rotation which will give the highest rate of heat penetration than can be accounted for by difference in density of the product alone. Thus, it appears that the maximum rate of heating of liquiform products occurs when the speeds of rotation are such that the headspace passes through the product at various levels in the container, the location of which level in each case depends upon the viscosity of product. The writer also found that the sterilizing efficiency of a process in which the cans are revolved about an axis located externally to the cans does not appear to increase progressively with increase in speed of revolution until a peak is reached, then to start immediately to decrease; the sterilizing efficiency appears to increase progressively with increase in speed of revolution until a maximum value is reached and this maximum seems to persist with practically no change through a

considerable range of further increase in speed of rotation before beginning to decrease due to the increase in volume of the product which is in a static condition in the extremity of the container that is farthest from the axis of revolution.

The above comments, including the conclusion of CLIFCORN et al, apply solely to the condition in which the container revolves about an axis which is external to the container. CLIFCORN et al (15) have United States patent rights on a process of this type in which the speed of revolution is such that " the centrifugal force and weight exerted by the contents will cause said gaseous space to move along a portion of the walls of the cans and then across the cans substantially at the center thereof ", which condition is said to occur when the centrifugal force on the product at the center of gravity of the product lies within the range of from one-half to one and one-half times the weight of the product.

The commercial possibilities of the end-over-end rotation type of process have been explored only slightly.

3. Preservation processes employing modified technic in preparing food, then using conventional procedure in processing

a) Strata-Cook process

Another method of speeding up the sterilization of products consisting of a mixture of discrete particles and a finely divided component in a liquid such as water or brine, which was developed and put into commercial use within the past few years, is the Strata-Cook process. This process is applicable provided the product can be formulated by assembling the three components of the product in the container in a specified manner so that the components can be stratified within the container and the finely divided component kept separated from the mixture of discrete particles and brine during the heating of the container for sterilization. After heating has been accomplished, the finely divided component is mixed with the discrete particles and brine, either by shaking the sealed container or by stirring after the container is opened.

The discrete particles and brine occupy more than half of the volume of the container and, since heat is transmitted rapidly into this portion of the contents by convection currents in the brine, the heating of the product, the components of which have been mixed prior to filling into the container. BALL (12) describes the principle of the method as follows :

" In this process, effective use " is made of the principle that, in " products through which heat passes " by means of conduction, the rate of " flow of heat is affected very little, " if at all, by a wide variation in " moisture content."

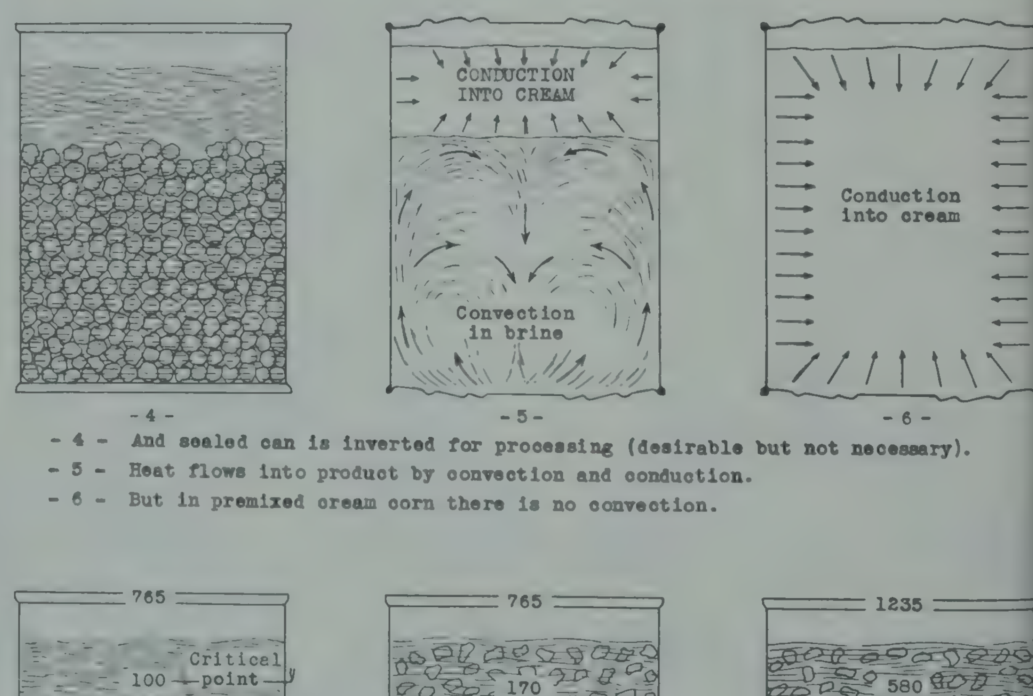
......

" During the application of heat " to the container, the temperature " rises rapidly within the mass of " kernels, just as it does in whole " kernel corn, because the heat is " carried to the center of the can by " convection currents in the brine. " Consequently, the temperature also " rises quite rapidly at the lower " face of the layer of concentrated, " finely divided, component.

" While the rate of heat conduction " within the cream is low it does not " take long for the heat to reach the " center of the layer because :
"
" 1) the layer is comparatively " thin;

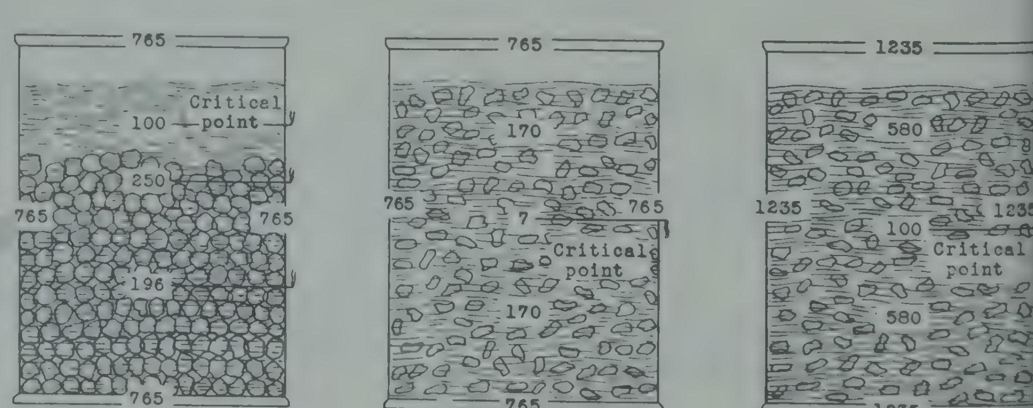
" and 2) the temperature rises rapid- " ly at all faces of the layer of cream. " The interior of the cream layer is " the last point in the container to " receive sufficient heat to accomplish " sterilization."

The method saves from 40 to 60 percent in sterilizing time, compared to that required for premixed products. Requiring, as additional equipment over that used conventionally,



- 4 - - 5 - - 6 -

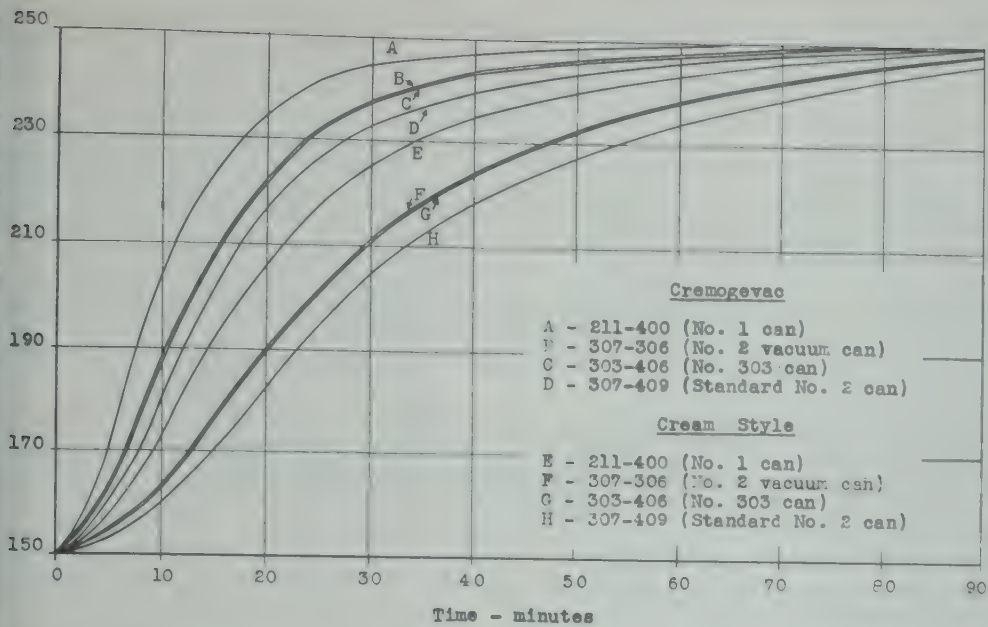
- 4 - And sealed can is inverted for processing (desirable but not necessary).
- 5 - Heat flows into product by convection and conduction.
- 6 - But in premixed cream corn there is no convection.



- D - - E - - F -

- D - In No. 2 cans, Cremogevac corn is sterilized in 46 min. at 250°F. Numerals indicate percent of lethal heat reaching different points.
- E - But after 46 min. at 250°F, only 7 percent of lethal heat has reached center of No. 2 can of premixed cream style corn.
- F - So it takes 74 min. at 250°F to bring center of premixed cream style corn of 100 percent lethal heat, overprocessing other parts.

Fig. 9. Patterns of heat flow and of distribution of lethal value in vertical planes passing through centers of No.2 cans of Strata Cook corn and premixed cream style corn. Food Industries.



Rapid heat penetration into Cremogevac corn, as compared with premixed cream style corn, is shown by curves. Food Industries

Fig. 10. Curves showing comparison of rates of heat penetration of Strata-Cook corn with those of premixed cream style corn. Food Industries.

only extra fillers for the finely divided component, this method of processing, at comparatively small expense, yields a product of markedly improved nutritive and organoleptic quality.

The name of this process, originally "Cremogevac" was changed in 1950 to "Strata-Cook".

Figures 9 and 10 illustrate interesting comparisons between Strata-Cook corn and premixed cream style corn. Figure 9 shows patterns of heat flow and distribution of lethal values in the cans; figure 10 shows rates of heating.

The process is completely described in U.S. Patents 1,502,196 (13) and 1,502,197 (14).

b) Cremogenized corn

In 1947 occurred the commercial introduction of a new type of cream style corn, known as Cremogenized corn.

The old type cream style canned corn, as defined by the United States Production and Marketing Administration is "canned sweet corn prepared from corn removed from the cob by shallow cutting through the grain and subsequent scraping, causing it to have a creamy consistency." BALL (10) describes cremogenized corn as being " made from kernels which are " cut from the cob in the manner followed by packers of whole kernel corn. The cut kernels are silked, screen-" ed, and thoroughly washed and inspected to ensure the absence of silk, husk, cob tissues, and other foreign " substances. A portion of the thoroughly cleansed corn is treated mechanically to reduce it to a creamy " semi-liquid, containing all the components of the kernels. Finally, the creamy semi-liquid is blended in " established proportions with whole kernels, sugar, salt, and water to form cremogenized corn, which is then " cooked, packaged, and sterilized."

Foremost the several advantages of cremogenized corn is that it is cream style corn in which the standard of cleaning the raw material is as high as that of whole kernel corn. Of almost equal importance is the advantage that the method followed in preparing this product permits the application of the Strata-Cook method of sterilization, previously described in this report. Other advantages are :

1) all parts of the corn kernel are included in the product, including all of the pericarp;
2) cob particles, which impart undesirable flavor, are excluded;
3) kernels which are past the most tender stage may be used in making the cream component of the product with a resulting improvement in appearance and texture and a removal of the necessity of adding field corn starch to the product.

The equipment in a cremogenized corn line includes all equipment of a whole kernel corn line up to, but not including, the filler, all equipment of the conventional cream style corn line starting with the brine tanks and the batch mixer, and including the blender, filler, closing machine, retorts and cooling canal, also a machine for comminuting the kernels to make the cream component of the product.

There were two semi-commercial operations on Strata-Cooked cremogenized corn in 1949. Operations with that process on a commercial scale began in 1950 with excellent results. In 1951, there were four commercial and one semi-commercial operations, all using No. 10 cans.

Cremogenized corn packed commercially in 1947 amounted to approximately 250,000 cases, in 1948, approximately 500,000 cases, in 1949, one million cases, and in 1950, two million cases, in 1951, more than three million cases are estimated.

The cremogenizing process is described in detail by COVER in U.S. Patents 2,484,375 (17) and 2,484,376 (18).

c) Frozen citrus concentrate. Florida process

One of the most dramatically successful new processes of all time in the canned foods field had its commercial introduction in 1948. This was a process for producing frozen concentrated citrus juice. This process was the result of many years of effort by the Florida Citrus Commission to produce, for the commercial market, citrus juice which, upon reaching the consumer, would have organoleptic quality closely resembling that of freshly extracted juice.

Expressed briefly, the purpose was accomplished through, first, extracting with the exclusion of bitter principle from the juice, second, concentrating by multiple stage evaporation at low temperature and pressure and in a very short time, and, third, withholding part of the juice from the evaporator and mixing it with concentrate to form the final product.

An article in Food Industries (2) describes the process briefly in these words : " The heart of " the successful process is quick, high-vacuum low-temperature (50 to 70 deg.) concentration of deaerated

" juice, followed by blending with unconcentrated juice, slush - freezing, canning and hard-freezing quickly " to 0°F."

In addition to the above-mentioned advantageous features of the juice concentration technic incorporated into this process, an extra - ordinary heat balance system was included in this step of the process, which is credited with accounting for an unusually low operating cost. HEID (40) comments on this system as follows : " In the Lake Wales process a three stage, single effect, falling film evaporator is operated " without steam. Ammonia is compressed in a conventional refrigeration compressor. Latent heat liberated " by the condensing ammonia is used to evaporate water from the juice, then vapor from the juice is condensed " by evaporating the ammonia. Surplus heat of compression may be removed by warming incoming juice or dis- " pelled in cooling water.

" An engineering advantage of this system is that the two pounds of ammonia which must be compressed " to provide 1058 B.T.U. occupy a space of only 7.2 cubic feet at 45°F., instead of the 1,208 cubic feet " occupied by one pound of water vapor at 60°F. Consequently, a small compressor may be used instead of a " large one.

" The heat balance of the system has been described by CROSS and GEMMEL on pages 1421-23 of Food " Industries, Volume 20, 1948. The initial unit was operated by a 300 h.p. direct connected 4 cylinder, " 11" x 10" compressor. After four evaporators of this size were installed, two larger evaporators were " ordered, which are operated by 700 h.p. compressors. This gives a production capacity of 1,000 gallons of " 42°Brix frozen concentrate per hour."

Of interest in connection with this development is a comment by RECTOR (56) that " it is probably " true that but for the fact that cold water for condensing purposes is very scarce in Florida, this highly " efficient piece of apparatus would not have been developed."

In the development of the process, it was found that citrus juice, even when concentrated at a temperature below 80°F, acquires a flat flavor due to loss of volatile constituents. For this reason, in order to retain fresh flavor in the concentrate, the procedure was adopted of concentrating a part of the juice to 60 percent total solids, then adding sufficient unconcentrated juice to form a final product having 42 percent of total solids. The unconcentrated juice provides the volatile components necessary to give a flavor to the reconstituted final product, which most tasters cannot distinguish from that of fresh juice.

This procedure was adopted after extensive experimental attempts to condense the volatile constituents removed during evaporation and restore them to the juice has resulted in failure because of the chemical instability of these volatile substances. A flow diagram of this system is shown in figure 11.

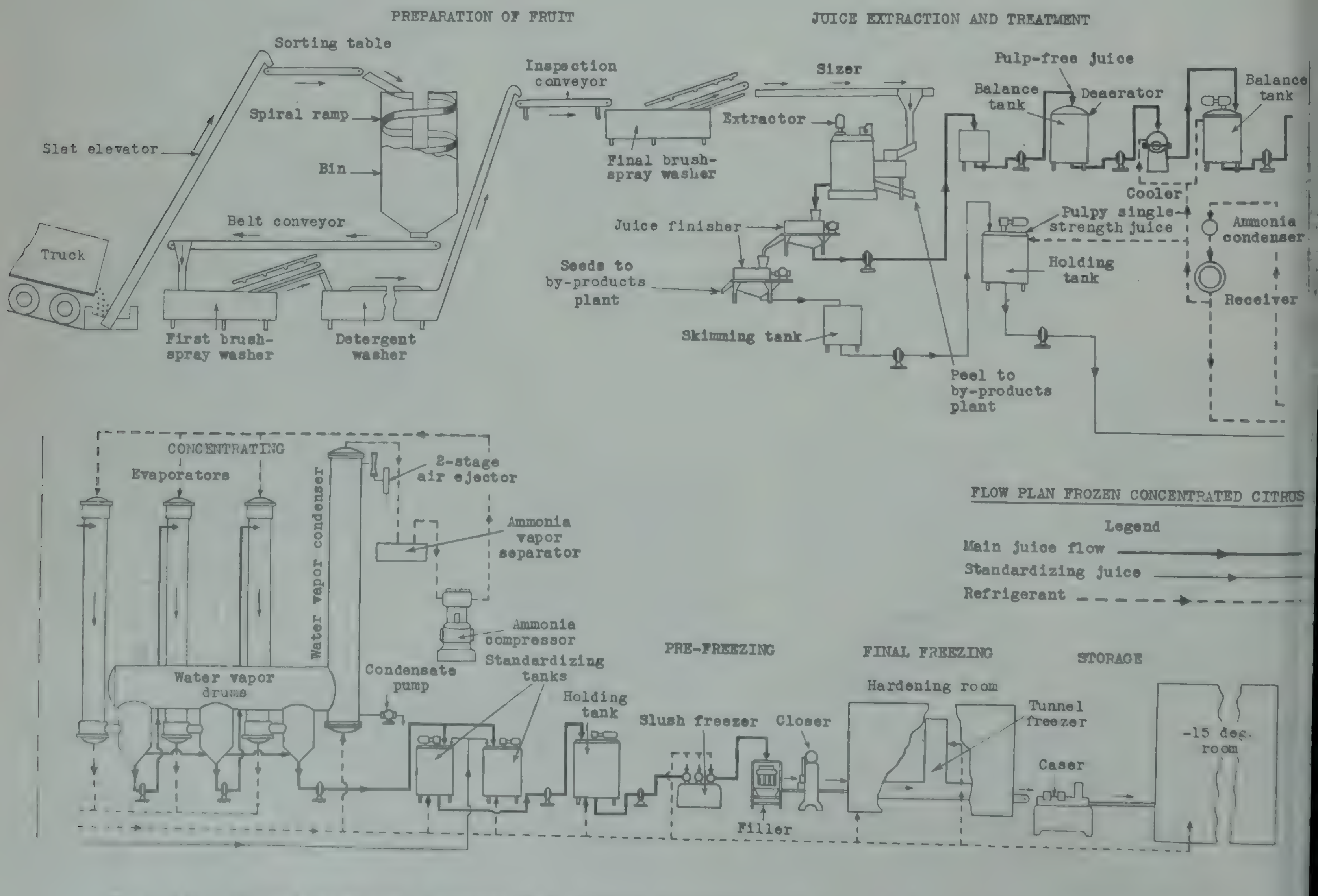


Fig. 11. Flow diagram of process for frozen concentrated citrus juice. Food Industries.

The blending step just described constitutes a modification of a procedure previously employed by RUESS (19), who blended a concentrate obtained by freezing with a concentrate made by evaporation under vacuum to yield a flavor-rich sirup, far superior to that obtained by vacuum pan concentration alone.

Whether or not, under this blending procedure, low temperature evaporation produces better quality than evaporation at higher temperatures may be a moot question, as indicated by the following quotation from RECTOR (56) :

" Commercially satisfactory frozen concentrated orange juice has been produced in evaporating equipment with temperatures of the heating medium as high as 180°F and liquid boiling temperatures as high as 110°F. Our skilled taste panels have not been sufficiently sensitive to prove clearly the superiority of the product evaporated at very low temperatures. In the Cross evaporator, however, these low temperature conditions are obtained with no increase in cost and since evaporation at low temperature is theoretically in the right direction, the industry has quite generally adopted the policy of going in the direction that good theoretical considerations lead."

Relative to advantages of frozen citrus concentrates, we quote again from RECTOR (56) :

" Competitors of frozen concentrate are primarily fresh fruit and canned juice. Compared with the fresh fruit, frozen concentrate is superior with respect to convenience. There is a convenience superiority 12 months in the year and, in addition, economy over fresh fruit about nine months in the year. Eventually, it is believed that there will be economy in using frozen concentrate 12 months in the year as well. Ultimately, sales promotion costs will be reduced and economies in freight and containers will come into full play.

" Compared with frozen single-strength juice, we have a convenience factor in frozen concentrate as well as superiority in flavor. Strange to say, the flavor in a 4 to 1 concentrate seems to stand up in zero temperatures better than does the flavor of frozen single-strength juice. There is an economic advantage of concentrate over single-strength juice also, inasmuch as with modern evaporating equipment, it is cheaper to evaporate water than to pay freight on it. There is, of course, a reduction of at least 50 percent in the container costs.

" As against canned juice the frozen concentrate enjoys no advantage in convenience. There is not much advantage in nutritive qualities, <u>but</u> there is very definitely an advantage in flavor.

....

" One of the reasons a concentrate keeps better than single-strength juice is that it contains originally only 10 percent of the typical flowery aroma of fresh juice. The straight juice contains all of the aroma and, when this changes chemically, it is somewhat objectionable. The change goes on progressively, even at zero temperatures, but it goes on so slowly that for the first six months of storage it is difficult to detect any change.

....

" Our experience is that juices concentrated by freezing and centrifuging are very superior at the beginning, but lose flavor more rapidly than do the products made by the "Florida process".

" The sale of concentrated orange juice was perhaps 3 million cans in 1947. In 1948 there were estimates of 50 million cans. For 1949, production is estimated at well in excess of 200 million cans and in 1950 this quantity will, no doubt, be doubled. Sales in 1950 are still more problematical, inasmuch as this industry appears to be fated to go through the usual period of over-expansion."

As often happens upon the first attainment of a balance between supply and demand by a new product, a problem associated with storage of frozen orange concentrate arose during the past year. There have been several occurrences of deterioration due to enzymic action. Doubtless, storage temperature is an influencing factor; however, trouble has been experienced during a comparatively short period of storage under ordinarily accepted commercial temperature conditions. Inasmuch as it does not appear practicable to control this enzymic reaction through temperature alone, experimentation is underway to determine whether or not pasteurization before concentration is feasible for frozen orange concentrate.

The " Florida process " is covered by U.S. Patent 2,453,109 (47), dedicated to the public by the Florida Citrus Commission.

4. Canning processes of miscellaneous type which have been or are being used commercially

a) Pressurized whipped cream product

During the 1930's, packing of whipping cream with a soluble gas (usually nitrous oxide) under pressure was begun with the use of returnable steel containers. The cream, saturated with the soluble gas under pressure, becomes whipped cream upon being discharged from the container through a valve and nozzle.

A typical procedure for packing this product was to put 7 ounces of 35 percent cream, seasoned with vanilla extract and sugar, into the container, vacuumize the container, and dissipate the vacuum with nitrous oxide, which is forced into the container until the desired pressure is reached, and then seal the container. The cream occupies about half the volume of the container; the remaining space is occupied by the gas, which, at the time the container is sealed, usually has a pressure of about 120 p.s.i.g., which decrease to about 75 p.s.i.g. as the cream absorbs gas. Since the overrun in dispensing is about 300 percent, each container delivers approximately one quart of whipped cream.

The first commercial distribution of this product came in about 1935. By 1940, there was much interest in the possibility of using single trip containers but before any can manufacturer could produce a can which it regarded as sufficiently strong, war restrictions on materials, including solder, practically dissipated all hope of being able to make a satisfactory can. After Pearl Harbor, rapidly expanding restrictions

soon ruled out the possibility of using tin plate for this product; so it was not until 1948 that the commercial use of single trip metal containers for gas-packed whipping products really took hold. GRAHAM (27) estimated the 1949 production of this product at about 30 million units. Products so packed are, for the most part, formulated products and not pure cream. They usually consist of cream, sugar, stabilizer, and flavoring.

Up to the present time, drawn steel cans, without side seams, have been used almost exclusively. Manufacturers of cans with side seams still are doubtful of this type of can being strong enough to stand up under the pressure required for this product.

Any one of three types of machines may be used in the packing operation. These are :

1) that in which the entire container is enclosed within a chamber;

2) that in which only the top of the container is enclosed during sealing;

and 3) that in which vacuum is drawn and gas is admitted to the container through a valve permanently attached to the container.

A procedure for sterilizing the product has not been developed. The cream product is pasteurized only; therefore, requires refrigeration storage.

GRAHAM (27) describes the single trip container as "an adaptation of a seamless drawn steel beer " can coated on the interior with a sanitary coating plus a microcrystalline paraffin type of wax. The ex- " terior is lithographed in color. The dispensing valve of rubber, stainless steel and/or plastic, is attached " to a tinplate cap which is clinched with a suitable gasket to the top of the can."

Detailed descriptions of dispensers which are attachable to single trip containers are contained in patents by MAHN (43, 44, 45). Containers primarily of the refillable type are described in other patents to GETZ (25, 26) and MARMOREK (48). GRAHAM (27) also describes the packing procedure in detail and discusses public health and safety considerations involved.

The rate at which equilibrium pressures are established in the container may possess a use which has not yet been appreciated. When pressure equilibrium is established by agitation immediately after packing, the overrun of the product, which depends upon the amount of gas dissolved in the product, is a maximum in the first portion of the product withdrawn from the containers and a minimum in the last portion of the product withdrawn. By delaying the establishment of pressure equilibrium, it would probably be possible to obtain a uniform overrum in all of the product withdrawn from the container.

b) Stero-Vac process

Not being restricted by rule to processes that have proved successful, we include in our enumeration of products and technics the Stero-Vac process, which had extensive use with citrus juices during the period 1938-1941 and a substantial commercial test with corn in 1940-1941; then faded from view.:

The essential steps in the Stero-Vac process were :

1) to put the food product into the container leaving a specified definite amount of headspace;

2) to close the container with a cover, in the center of which was a valved opening;

3) to clamp the container tightly between two members of a processing machine, one of which members places into communication with the valved opening in the end of the container a tube which could be connected to either a vacuum pump or a source of steam under pressure;

4) to produce vacuum within the container by withdrawing air through the valved opening in the top of the container;

5) to invert the container while it was still clamped securely between the two members of processing machine;

6) to force steam under pressure through the valved opening into the food in the container;

7) to seal the valve in the end of the container;

8) to hold the container, while the food was at the high temperature produced by the steam entering the container, for a sufficient length of time to sterilize the food,

and 9) to cool the container.

A description of this process is found in U.S. Patents 1,732,227 (222) and 1,938,821 (23).

Citrus juice packed by the Stero-Vac process was generally accepted as being as good as, but probably no better than, similar juice packed by the flash heating process. Therefore, after a few years of use the process was discontinued. With low acid foods, corn and peas, an opportunity to judge the process in commercial use was not provided because extensive spoilage from understerilization occurred throughout the period of commercial use of the process.

During a period of non-use of the process, about 1945-1946, a modification in the technic was introduced. The valved closure was eliminated and the container was held within a chamber under steam pressure while it was being treated. The food, consisting only of solid pieces, was put into the container after which the container, within a chamber, was vacuumized while the container cover was being held directly over the container in proper position to be applied to the container and separated from the container lip as slightly as possible without effecting a seal. After being vacuumized, the container was immediately subjected to steam at processing temperature, which may have been between 260 and 280°F and the jar and its cover were inverted while retaining the same relative positions with respect to each other. The container was then subjected to steam under pressure for approximately two minutes, during which time the steam entered the jar and heated the food to a temperature about 6° below the temperature of the steam outside the container. The container and cover were then rotated again into their normal position and the container was sealed wit

he cover. The container was cooled by means of a water spray. This method was a retrogression to a procedure, which was advanced by FENN (21) in 1925.

While this modification improved the process mechanically, it did not remove the salient faults of he method and the process never was given a new lease on commercial life. One inherent fault was chiefly esponsible for the failure of the Streo-Vac process. This was the wide variation in sterilization heat reatment of the food in different individual containers and the absence in the technic of any provision to revent this wide variation. If the heat treatment for low-acid products were so gauged as to ensure steriization of the food in every container, the food in some containers would be overcooked; moreover, the heat reatment would be so long that the cost of operation would be inordinately great.

5. Processes with prospects for commercial use

Processes which will now be mentioned are thought not yet to have had commercial application, hoever, since they appear to be practically ready for this step, some may already have experienced it without nowledge of the writer.

Milk

In the development of the HCF process, a vast amount of work was done on evaporated milk. This work evealed a baffling problem on physical stability of high - short sterilized evaporated milk, which problem as for fifteen years stood between this product and a commercial trial. More recently frozen concentrated ilk has been receiving attention; many believe the technical and other problems here to have been practically olved and they believe that frozen concentrated milk will soon be on the market. GEMMILL (24) gives a esume on five technical and three economic questions to which conclusive answers may not yet be known. At east two of these questions pertain to physical stability which presents a problem when the milk is concenrated beyond a ratio of 2.5 to 1.

Both flash heating and controlled viscosity are instruments of known value in establishing physical tability in concentrated milk. Technics for employing these instruments, described by BALL (6, 8, 9) and OOK (51) might be applied with benefit in the preparation of both frozen concentrated milk and sterilized oncentrated milk.

Apparently destined to figure in the competition for consumer acceptance between frozen and highhort sterilized milk is a process developed by Roy R. GRAVES, with the use of which a program of commercial anning of milk (not concentrated) for the Alaska market is reported to be in an organization stage. In a ersonal communication to the writer, GRAVES describes the process as follows :

" Milk is drawn from cows on farms in a milking parlor, where cows can be properly prepared for " milking and where the milk from each cow can be inspected for normalcy. The milk is produced without ex-" posure to air, and is drawn from all the cows into a vacuum tank. On the completion of the herd milking, " these tanks are moved by truck to the processing plant.

" In the processing plant the milk is moved under vacuum through a closed system, first through a " homogenizer, then through a heat exchanger where the milk is heated very rapidly to sterilization tempera-" tures, then the milk is cooled rapidly and finally is aseptically canned and sealed and moves into cold " storage."

Obviously, in this process, as in the Smith-Ball process previously described, controlled sanitation plays a major role in keeping down the lethal requirements of the heat treatment by which the product s sterilized. Operations are reported about to begin with the use of the Martin system of sterilization.

Another sterilizing process was announced in trade journals in 1949 (3) as "Dairy Dream Pure Cream" which was being canned commercially in 10 ounce and 46 ounce metal conteiners. This also is represented as a sterile product and it is not reported to contain a stabilizing substance such as "Avoset" contains. The sterilizing technic is not disclosed.

6. Processes for the future

Two processes which are occupying prominent places on the stage of current research should be mentioned, even though their commercial application appears destined for a prolonged delay. These are high frequency sterilization and sterilization with antibiotics.

a) High frequency sterilization

High-frequency sterilization is accomplished either through direct electronic effect without appreciable heating, sometimes designated as "ionizing radiation", or through induction heating. Gamma rays, X-rays, and radio frequency waves are used to obtain the various effects. A study of this type of sterilization constitutes a major project at the Massachusetts Institute of Technology under sponsorship of industrial concerns in the food field. Extensive experimental work on electronic sterilization without heat has been carried on in the Electronized Chemicals Corporation Laboratories in Brooklyn, New-York. Other laboratories, including the Radio Corporation of America Laboratory, as well as large food packers, have been engaged in experimental work on high-frequency sterilization.

b) Canning with antibiotics

The second process belongs essentially in the category of processes involving the use of chemical

preservatives. The particular phase of this processing technic which has attracted much interest in recent months is that in which the preservative agent is an antibiotic, combined with mild heat. Results of an investigation, which was chiefly responsible for the attention the method is currently receiving, is described by ANDERSON and MICHENER (1). Appraisals of the prospects for commercial use of the method have been published by MORSE (52) and CAMERON (4).

c) Fruit juice by trituration

A comparatively simple technical development, not in food sterilization, has recently been made experimentally by the writer in the preparation of juices from high acid or medium acid foods. A new technic in treating the raw material results in improved physical stability of juices containing fibrous and other insoluble portions of the raw material. The stability is produced by effecting a specific type of comminution of the fibrous solids while these solids are in a concentrated state - comminution of the type which is effected by a colloid mill having a conical star gear type of rotor and a grooved stator, each with cutting edges on its periphery. This comminution, which shreds the fibers into threads of filament thickness also frees the soluble pectinous components of the raw material in such a way as to produce a thickening of the comminuted material. The latter material is mixed with juice containing very little insoluble solids, which has previously been extracted from the raw material, to form the final product containing the desired quantity of insoluble solids. The juice thus formulated possesses better suspensive properties than juice produced by customary methods so that settling of the insoluble solids in undisturbed juice is greatly delayed. The procedure is particularly beneficial with pineapple juice.

An additional advantage of this juice preparation technic lies in its ability to convert products like tomatoes into juice containing the seeds or both the seeds and skin in finely comminuted state, thus conserving the nutritive values contributed by these components.

The merits of this method of producing juice have yet to be proved commercially although the process appears to be ready for commercial use.

d) Carbonated beverages

Another recently developed canning activity which should be mentioned among "Products and Technics" is the canning of carbonated soft beverages. Three pilot operations on a semi-commercial scale were conducted in 1949 in producing and marketing Pepsi-Cola, a well known product of this kind. The following brief report was contained in a personal communication from the Sales Planning Manager of the Pepsi-Cola Company:

" Production and marketing problems were considerable. The experiment has ended, and I do not know " at the moment when it might be undertaken again. For this reason, I am unable to give you the kind of " conclusive evidence which you desire. .... Primarily, however, our development of this container has " been hampered more by marketing problems than by production problems, because of the fact that the cost of " the materials and of the labor so increases the price to the consumer that the package loses much of its " attractiveness to the purchaser."

II. OTHER CANNING PLANT OPERATIONS

Departing now from the field of specific products and processes, we shall make a brief survey of items of equipment designed for use with no product in particular, which were brought into commercial use during the last decade.

a) Hydromatic retort crate loader and unloader

The problem of bringing cans of food into orderly array for casing, following processes in which the cans have been handled in disorderly array, is a bothersome one. This problem is solved rather neatly by the Hydromatic crate loader and unloader, in which is combined a hydromatic elevator with a retort crate having a removable bottom. A published description (11) of the device is as follows :

" A loading table with sheet steel top, capable of holding about 100 containers is placed at the " end of the canning line. The containers are conveyed onto this table from the closing machine. Built into " the floor at the end of the table is a hydromatic lift, having a circular platform slightly smaller in di- " ameter than the diameter of the removable bottom of a crate.

" Containers are made to slide by being pushed from the loading table onto the crate bottom until " the bottom is filled. Then the crate bottom, holding the layer of containers, is lowered until a perforated " sheet steel separator, which is placed on top of the layer of containers, has assumed the position which " was previously occupied by the crate bottom. A layer of containers is then slid onto the separator sheet " and the cycle of operations is repeated until the crate is filled.

" For unloading, a filled crate is placed over a Hydromatic lift at the end of an unloading table " The lift, acting upon the removable crate bottom, raises the load of containers until the separator sheet " beneath the top layer is just slightly higher than the unloading table. The layer of containers is en- " circled by a strap which is operated upon by a hydraulic device to strip the layer of containers off the " separator sheet onto the unloading table. The top of the unloading table is a chain conveyor which moves " the containers into a single filling device, from which the containers are conveyed to a labeler or to a " case packer. As in loading, the cycle of unloading operations is repeated with each successive layer of " containers.

" The manufacturer of this equipment states that No. 2 cans can be loaded by one operator at a rate " of 300 cans per minute and unloaded by two operators at a rate of 400 cans per minute. He claims also that " No. 303 jars can be loaded by one operator at a rate of 150 jars per minute and unloaded by one operato

at the same rate."

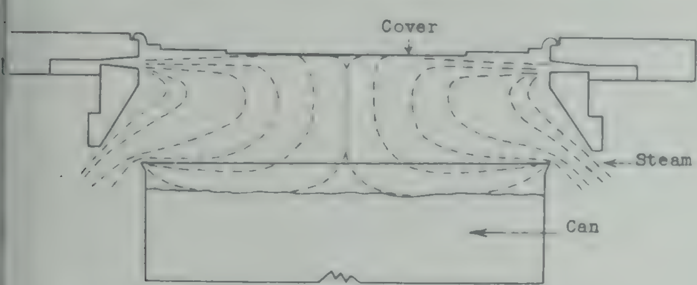
The containers are not roughly handled and always remain in upright position. The system has been n use for several years.

b) High speed fillers

A phenomenal increase in rate of filling containers has been accomplished in recent years. For rained or chopped foods (baby foods), for example, a filler is now in use having an operation speed of 400)2 - 214 cans per minute and is so designed as to be free from action tending to incorporate air into the od and free from spots which might harbor spoilage bacteria. For products of particulate type, such as as and whole kernel corn, fillers are now in use having recommended operating speed of 300 No. 2 cans per nute. With these fillers, it is possible to have a new chronological order of procedural steps when brine cked foods are being filled. By filling the brine ahead of the solids, the entrapment of air pockets in e product is practically avoided. This advantage is particularly important when the liquid in which the oduct is packed is more viscous than water. Another recently introduced filler will fill sirup onto grape-uit sections, sauce or oil onto meat or fish products, etc.. in small cans at a speed of 200 cans per minute. avoid aeration of a liquid product such as juice during filling into cans up to No. 2 size, a recently rfected filler equipped with extension tubes is used. The tube projects down into the container to a point close to the bottom as practicable and is curved to direct the flow of liquid against the sides of the ntainer. This filler, for cans up to No. 3 size, has a maximum capacity of 125 cans per minute.

c) Steaming device

The period since 1940 has marked the beginning and the rapid growth of high-speed steam flow closure metal containers although low-speed operation of this type on both glass and metal containers, particularly the former, had experienced its commercial initiation years earlier. This method of closing containers, sometimes referred to as " Steam-Vac " closure, was developed as a means of producing the necessary vacuum in liquid carried products without having to use exhaust boxes which occupy extensive plant space.



Steam injection into headspace for purposes of obtaining vacuum.

ig. 12. Vacuum by steaming during closure operation. Diagram of steam currents in headspace. Continental Can Company.

In this procedure, steam is injected into the headspace of the container during the time when the container lid is being positioned and sealed onto the container. If properly injected, the steam replaces practically all the air in the headspace of the container; thus, by sealing the container at the critical moment when the air has been displaced, a potential vacuum will be produced in the headspace, which will become real almost immediately after the container is sealed, when the steam in the headspace condenses. The injection of steam is accomplished through specially designed steam ports around the seaming heads of the closing machine. Best results are obtained when a considerable volume of steam flows at a comparatively low velocity. Gauge pressure of steam back of the jets is usually about 10 pounds per square inch. The vertical cross sectional diagram in igure 12 indicates the course of steam currents in the headspace just before sealing the can.

As indicated above, this method is best suited for liquid carried products, particularly those conaining a full complement of brine or syrup. With syrup packed products, in steam flow closure, just as in echanical vacuum closure, best results are obtained when the containers receive the syrup in a vacuum syruping unit, by means of which entrapment of air during filling is effectively prevented. Steam flow method f producing vacuum is only partially effective with solid products having rough surfaces exposed to the eadspace, such as meat or fish. Curves in fig. 13 and 14 (p.18) show that, when "steam-vac" closure system is roperly employed, the magnitude of the final vacuum depends only to a minor degree upon the temperature of he food whereas when "steam-vac" closure is not used, the amount of final vacuum depends almost exclusively pon the food temperature at time of sealing. Figure 15 (p.18) shows that, with "steam-vac" closure, for gross eadspace within the range of from 1/4" to 1/2", the final vacuum increases rapidly as the amount of headpace is increased.

d) Pipe blanching

Brief mention will be made of hydraulic pressure blanching because, although this operation received ts baptism in industry in 1935, it enjoyed its greatest increase in popularity during the past decade, which rought it into widespread use in the blanching of peas, beans, and whole kernel corn. Hydraulic pressure lanching is accomplished by pumping water, with the food particles in suspension, through tubing of 4" diameer. As a rule, approximately 80 percent of the mixture is water and the other 20 percent is the product.

The water is heated by steam in jackets which enclose a portion of the tubes and by steam injected into the water in the supply tank. The length of blanch is usually about two minutes. Advantages claimed for pipe blanching over old style blanching are : 1) better sanitation, 2) greater flexibility, 3) greater uniformity of treatment, 4) space economy, 5) steam economy, 6) shorter blanching time because of pressure operation, and 7) cleaner product.

With corn, the primary use of the system oftentimes is conveyance rather than blanching. For conveyance without blanching, cold water is used.

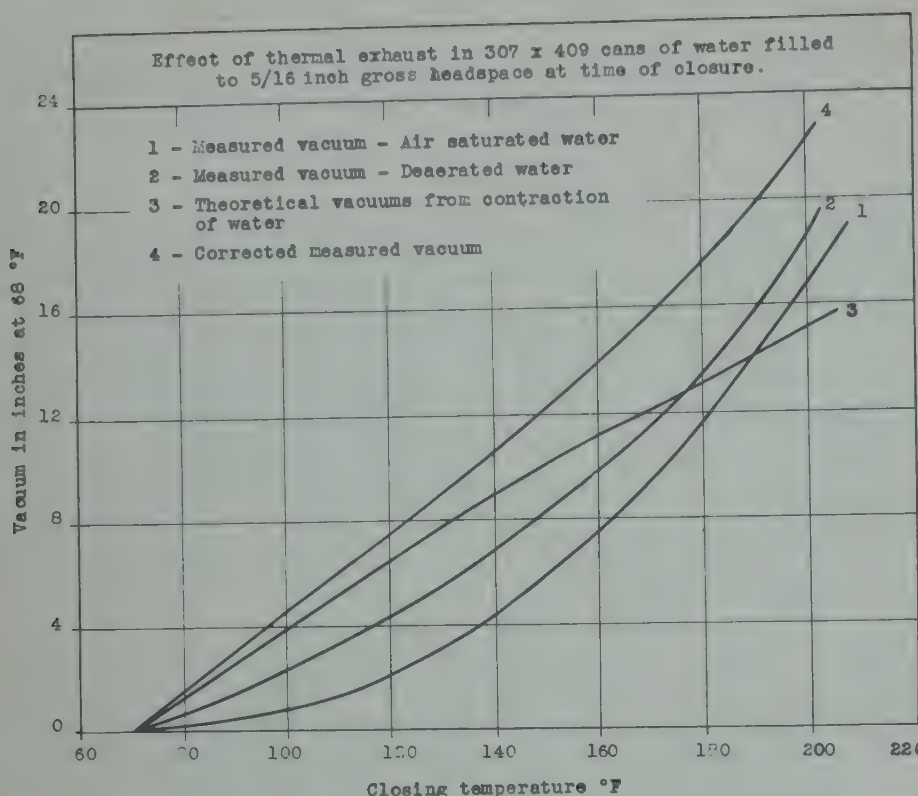


Fig. 13. Effect of closing temperature of water filled to 5/16 inch gross headspace in 307 x 409 cans, without "Steam-vac" closure. Continental Can Company.

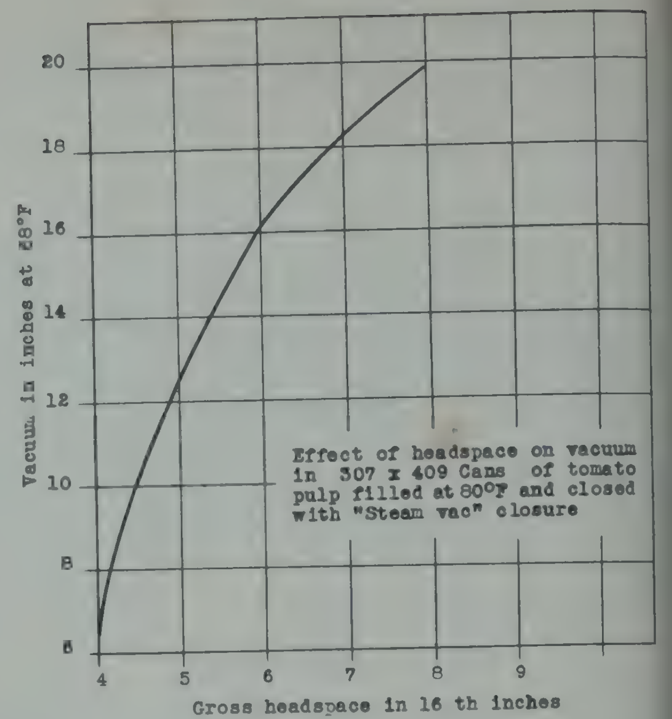


Fig. 15. Effect of headspace on vacuum in 307 x 409 cans of tomato pulp filled at 80°F and closed with "Steam-vac" closure. Continental Can Company.

e) Froth flotation cleaning

The removal from discrete particle vegetables of pieces of foreign matter and of vegetable units having major physical defects presents serious problems in canning plant operations. Flotation cleaning involving the combined use of specific gravity effects and controlled movement of liquid fails with most vegetables to give the type of separation which is required and the flotation operation therefore must be supplemented by thorough belt inspection and even this does not give the assurance that is desired of freedom from undesirable particles in the finished product, such as nightshade berries, tarweed seed, dogfennel, blossoms, and other weed parts in canned peas.

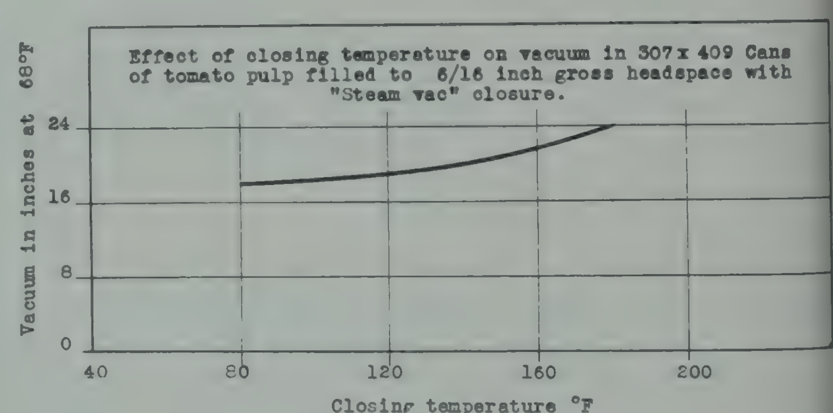


Fig. 14. Effect of closing temperature of tomato pulp filled to 6/16 inch gross headspace in 307 x 409 cans, with " Steam-vac " closure. Continental Can Company.

In 1946, a commercial trial was made of a froth flotation cleaning method, a published description of which has appeared in 1945 (55). This method utilizes an emulsion of water, oil, air, and a detergent, which separates nightshade berries and other trash from peas through action caused by difference in wettability of their surfaces. Foam clings to the less wettable surfaces and causes the objects having such surfaces to float while the good peas sink. A description of these operations was published in 1947 (53).

NEUBERT (54) describes the process as follows :

" Equipment necessary for the froth-flotation process consists of a treater, a separator, and an " auxiliary emulsion reservoir. Each of these units operates separately and requires a separate emulsion-" circulating pump. The treater receives washed and drained raw peas from the preparation line, wets them " with treater emulsion, drains off the emulsion, and delivers the treated peas to the separator. The sepa-" rator classifies the peas and foreign material into sinkers and floaters on the basis of differences in " wettability. The sound peas (sinkers), flowing from the separator by a gravity outlet, are drained from " the separating emulsion, rinsed with cold water and returned to the preparation line. Foreign material " and debris (floaters) are carried over a weir by the separating emulsion and are discarded into a sewer " after the separating emulsion has been recovered. The auxiliary emulsion reservoir is used to prepare and " store emulsion for use in replenishing the emulsion in the separator and treater during continuous ope-" ration. One auxiliary emulsion reservoir can serve several treater-separator units."

Since 1946, the use of froth-flotation cleaning has been extended to lima beans and vegetable soy and, during the past three seasons, this process has been found effective in cleaning raw whole kernel sweet corn by the removal of corn borer larvae, worm fragments, chaff, and kernels damaged by corn borer. The feasibility of froth-flotation cleaning of very young corn kernels may not yet have been established, however. Because of the fact that the specific gravity of very immature kernels is close to that of water sound kernels of this type might float in a froth-flotation treatment and thus be wasted.

f) Thermocouple for heat penetration

For many years, heat penetration tests in canned food have been made with the use of thermocouples attached to wire leads which extended from inside to outside of the retort through packing. The leads of the earlier types of thermocouples (+) were fixed in a stuffing box which had to be securely attached to the wall of the retort throughout the period of use of the thermocouples. With this arrangement of couples, a can was filled and sealed and a stuffing box for a thermocouple was attached to the can, usually by soldering. It was necessary to have the can near to the retort when the thermocouple was inserted into the can because the thermocouple lead was attached to the retort.

In 1923, the writer, in the laboratories of American Can Company, introduced the use of a simple asbestos covering for the thermocouple leads, which permitted the leads to be placed between the retort cover and the gasket, thus making it unnecessary to attach the leads to the retort. When certain types of closing machines were available, it was possible to seal a can after a thermocouple of this type had been installed in the can. The advantage was gained, therefore, of being able to secure a thermocouple in place in an empty can, then fill and seal the can and take it to the retort for the heat penetration test.

This type of thermocouple also has now been largely outmoded and is seldom used. Because the rigid stem of such a thermocouple usually projects a considerable distance from the can, sealing the can containing a thermocouple is impossible in high speed closing machines. A connector type thermocouple, so-called because the lead wire is detachable from the thermocouple, was developed several years ago. A test can, containing a thermocouple of this type, can be sealed by high speed closing equipment. The lead wires, being detachable from the thermocouples, are usually joined into a cable and, with this cable, the packing gland for passing the lead wires through the retort body, has come back into use.

ECKLUND (20) describes the thermocouple as follows :

" The newest type of heat penetration thermocouple, in addition to having the connector feature, is " so designed that the thermocouple and the receptacle which holds it do not project from the side of the " can. This permits normal closure of the can on commercial closing equipment. The thermocouples are made " in various lengths to fit various can diameters, or a long thermocouple, by use of a packing gland, may be " used as an adjustable length thermocouple. However, when long thermocouples with packing glands are used, " special care in filling and closing the container is necessary. .... The essential units are :

1. thermocouples and receptacles for holding the thermocouples in the cans;
2. heat penetration cable consisting of lead wires fitted at one end with connectors for attaching to thermocouples, the other ends being attached to a selector switch. A packing gland is located in the middle of the cable to seal the wires through the retort wall;
3. a potentiometer for indicating the temperature obtained."

Tests have established the reliability of these thermocouples for accuracy.

For information contained in this report, the author is indebted to H.A. BENJAMIN, American Can Company; J.B. GILLETT, Berlin Chapman Company; L.E. CLIFCORN, Continental Can Company; P.C. WILBUR, Food Machinery and Chemical Corporation; E.C. RITCHELL, Green Giant Company; J.L. HEID, Golden Citrus Juices, Incorporated; W.M. MARTIN, James Dole Engineering Company, and R.A. STARK, Scott Viner Company.

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(+) It is of interest that the leads of the first thermocouples used by BIGELOW and BOHART about 1916 were encased in lead tubing to give them flexibility and moistureproof protection. About 1918, the lead was replaced by rubber.

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XIV. TWELVE YEARS OF TECHNICAL PROGRESS IN THE UNITED STATES CANNING INDUSTRY

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During the 12 years since the First International Canners Convention was held the production of canned foods in the United States has undergone a tremendous expansion, increasing from 337 million cases in 1938 to an all-time high of 630 million cases in 1946, then leveling off to 560 million cases in 1950.

Technical progress in the industry has been commensurated with the growth of the industry. New sterilization techniques have been devised, new products have been created, new equipment has been developed, and in addition major changes have been effected in the character of the metal containers supplied the industry. Many of these new developments have been discussed in the scientific, technical, and trade journals. Time does permit an elucidation of all of the interesting changes that have occurred. Accordingly, we have elected to discuss briefly only a few outstanding developments which have had far-reaching significance.

I. NEW AND IMPROVED CANNED PRODUCTS

A statistical study of the can manufacturing industry indicates that a number of factors have contributed to its steady growth. Perhaps the most important is the industry's ability continually to find products which can be merchandised more successfully in cans.

1. Beer

One outstanding success story of the last 15 years in the metal container field is the beer can (1) 2). Although it is not a new product, the beer can having been introduced by the American Can Company in 1935, its record is so remarkable that it deserves discussion.

NOTA : Figures between ( ) refer to Bibliography, p. XIV - 16.

In 1950 over 5,000,000,000 beer cans were manufactured in the United States. One out of every si cans manufactured was a beer can. The introduction of cans has had a profound effect upon both the con sumption and distribution of beer. In 1934 approximately 40 million barrels of beer were produced, of whic 25 per cent were packaged in retail containers. Fifteen years later production was almost 85 million barrels 70 per cent of which was filled into retail packages and approximately 25 per cent of this volume was i cans (3).

The greatest technical progress probably occurred in the packing procedures where line speeds hav been increased to as high as 400 cans per minute with a simultaneous reduction in the amount of air in th beer. Since air has a deleterious effect on beer, it may be of interest to discuss how air in beer is hel to a minimum.

The beer is brought into the filler under a counter pressure sufficient to prevent much loss o carbon dioxide. In the filler, counter pressure is maintained which is equalized with the pressure in th empty cans. The transfer of the beer into the cans is also made under counter pressure. The beer must reac a quiet state prior to being released to the atmosphere to avoid excessive foaming during transfer to th closing machine.

Since the rate of absorption of gas into beer is a function of the surface exposed, pressure, and temperature, when air is used as a counter pressure it is desirable to employ only as much pressure as is necessary to insure quiet filling. It is also desirable to keep agitation at a minimum.

The final operation as the cans move to the closing machine is elimination of headspace air. The most common method, used with bottles as well as cans, involves agitation of the beer to cause foaming, thus filling the headspace of the containers with foam and released carbon dioxide. Such agitation can be obtained by jetting with carbon dioxide or beer. Care must be taken, however, to avoid excessive spillage.

Early in the development of beer canning it was realized that jetting alone could not produce uniform low air content, uniform carbonation, and the best yield in terms of unit packages per barrels. After considerable research "gas flow closure" was devised as a supplement to jetting and as a means of further eliminating headspace air without excessive foaming of the product.

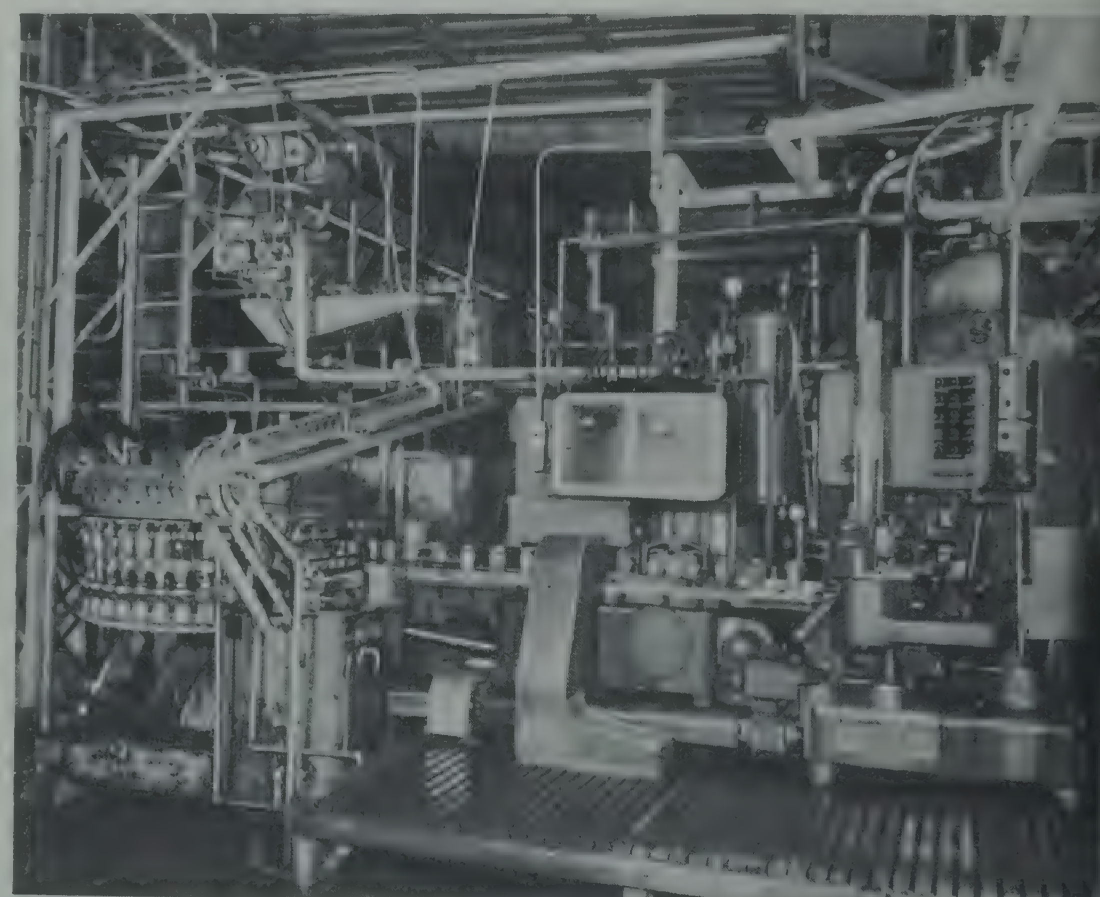


Fig. 1. High speed closing machine coupled with beer filler.

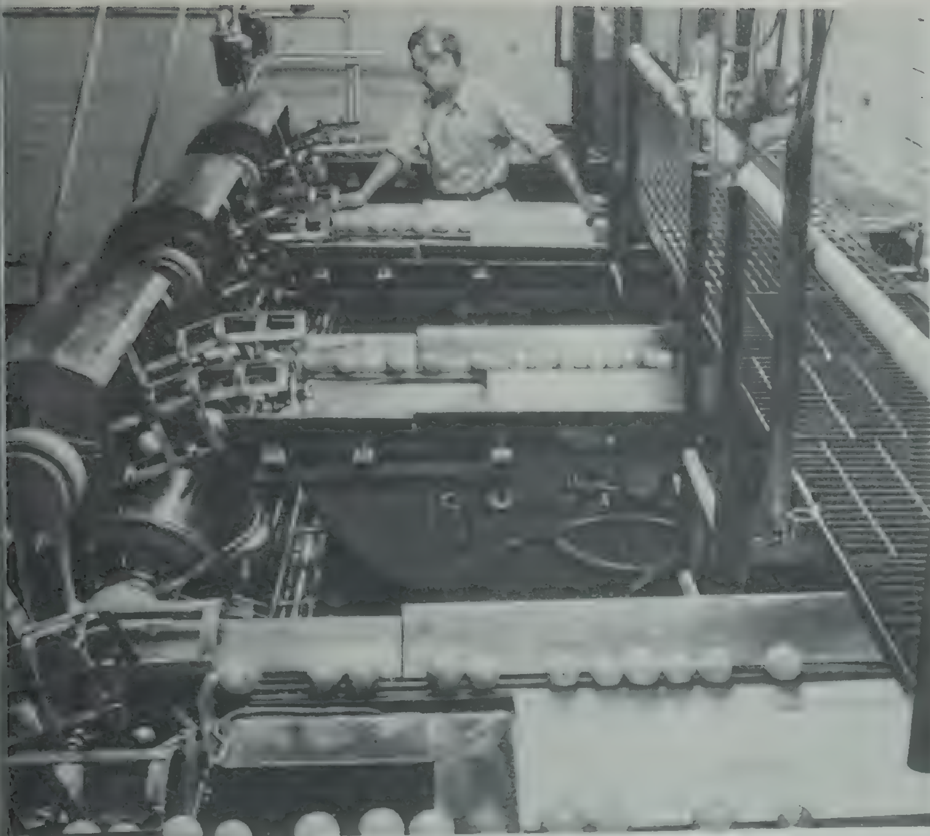
In the gas flow procedure a stream of low pressure carbon dioxide is delivered across the headspace of the cans, flushing out the residual air. The flushing action is continued until th can is brought into seaming position with the cover in place. This is accomplished by a separate rotary turr action which moves with the can and delivers a sustained flow of carbon dioxide until can and cover are a sembled. Since the flow of gas is automatically turned on and off for each can, a minimum of gas is consume A photograph of a high speed closing unit coupled with a filler is shown in figure 1.

As far as the beer can itself is concerned, the principal change has been in the amount of tin the plate from which the container is fabricated. Originally made from hot dipped tin plate (1.50 lb. of t per base box), most beer cans are now made of electrolytic plate bearing only 0.25 lb. per base box. The t is now being stretched to cover six times as much area as before the war, and even lighter coatings are bei considered for cans during the current tin shortage. Despite the reduction in tin coating weight, vario technical improvements in the organic coatings applied to the interior of the cans have kept the quality beer cans comparable with that of the prewar containers.

2. Frozen concentrated orange juice

Frozen concentrated orange juice is another success story of the postwar period. First packed a commercial basis in 1946, last year over 25,000,000 gallons of concentrate were canned, mostly in 6 cans (4). More than a million tons of fresh oranges were required, almost 25 per cent of the national cr (5). The excellent consumer acceptance of the product is probably due to the fact that the reconstitu product tastes remarkably like fresh orange juice and the retention of ascorbic acid is excellent.

Several procedures for preparing the concentrate are now employed (6, 7, 8). In one method the fruit is sorted, washed to remove dirt and bacteria, resorted, and rewashed just before the juice is extracted. Figure 2 shows fruit moving to one type of extractor.



.g. 2. Citrus juice extractors. (Western Canner and Packer).

After extraction the juice is flowed over a vibrating screen to remove seeds and large pieces of pulp. About 80 per cent of the juice is then passed through a fine screen finisher, producing a relatively clear liquid, while the other part of the juice is pumped through a coarser screen, thus retaining a portion of the pulp and juice sacs.

The clear juice may or may not be subjected to vacuum deaeration, after which it is usually chilled by refrigeration coils to 40°F and then pumped to holding tanks. The pulpy juice is also cooled and then held in other tanks for later addition to the concentrated juice.

The clear juice enters the low-temperature, high-vacuum evaporator, which will be described in detail later, at from 8 to 13 per cent soluble solids, and emerges at approximately 60 per cent solids. The concentrate is pumped continuously from the evaporator into insulated, cooled tanks maintained under vacuum. In these tanks, the unconcentrated juice containing juice sacs is added and the concentrate thereby diluted to produce a product containing 42 per cent soluble solids. A phorograph of a juice concentration unit is shown in figure 3.

Fig. 3. Frozen citrus juice concentrate plant. (Western Canner and Packer).

It is this cut-back with fresh juice containing all of the volatile flavorful constituents of the orange, plus the low-temperature storage which slows down the degradation of limonene in contact with an acid aqueous media, which is largely responsible for the overwhelming public acceptance of the product. Thermally sterilized citrus concentrates has been produced in the United States for many years for fountain syrups, beverage bases, etc.., but had not been considered a direct competitor of fresh orange juice. In their preparation many of the flavorful constituents of the orange were either removed or destroyed and, in addition, there was associated with them the inevitable degradation of limonene which always occurs when citrus oils are stored in contact with acid juices at ordinary temperatures. When these conditions were corrected, through the process of cutting back the fresh juice and storing at freezing temperatures, a new industry was created.

After the cut-back with fresh juice, the concentrate is cooled to approximately 25°F. It is then pumped through another heat exchanger which partially freezes it into a creamy slush. This slush is filled into cans which are then closed, with or without vacuum producing closures. The cans are conveyed to hardening coils in a room at -10°F. After hardening for 24 hours the cans are cased and stored at -10°F.

Despite tremendous strides within a very short period, the production of orange juice concentrate is not without its problems. One, which is encountered occasionally because the product is not given any thermal treatment sufficient to inactivate enzymes, is flocculent separation of the reconstituted juice due to enzymic activity on the naturally occuring pectins. Pasteurization of the juice before concentration is under study as a means of controlling such action.

Pasteurization has been avoided to date because of the fear that the heat treatment would affect the flavor of the product. That fear was probably based on the old long time - low temperature methods of pasteurization. Recent research using "flash" heating in a tubular heat exchanger has indicated that juice can be pasteurized without significant effect upon flavor providing it is quickly concentrated and chilled to freezing thereafter.

Spoilage problems have also been encountered due to growth of bacteria in the evaporators. This spoilage has been controlled by periodic shut - down to clean the quipment. However, pasteurization of the juice to concentration would permit much longer operations between clean-ups.

The low - temperature, high-vacuum concentration plus cut - back with fresh juice principle has also been applied in canning frozen concentrated apple, grapefruit, lemon, and pineapple juices. Frozen concentrated tomato juice, without cut - back of fresh juice, is also on the market. Many of these products are rather new but excellent consumer acceptance is predicted from them.

3. Blair peas

Peas have been canned for many years and the consumer has become accustomed to the characteristic color of the product. However, the introduction of frozen peas has demonstrated to housewives that the color of canned peas is "olive green" rather than natural "pea green".

WILLSTATER showed (9) that the natural green color of all higher plants is due to a mixture of chlorophyll A, $C_{55}H_{72}O_5N_4Mg$ and chlorophyll B, $C_{55}H_{70}O_6N_4Mg$. From his work it might be surmised that the change in color which peas undergo in canning is due to a change in the structure of the chlorophyll molecules whereby the non-ionic magnesium is replaced with hydrogen ion and chlorophyll irreversibly converted to pheophytin. This change is accelerated in acid media.

BLAIR (10) of this laboratory, has used the base exchange properties of peas, originating in pectin-like compounds to build an alkaline reserve in the peas and thus stabilize the chlorophyll. The basic outline of the procedure, depicted diagrammatically in figure 4, involves three steps :

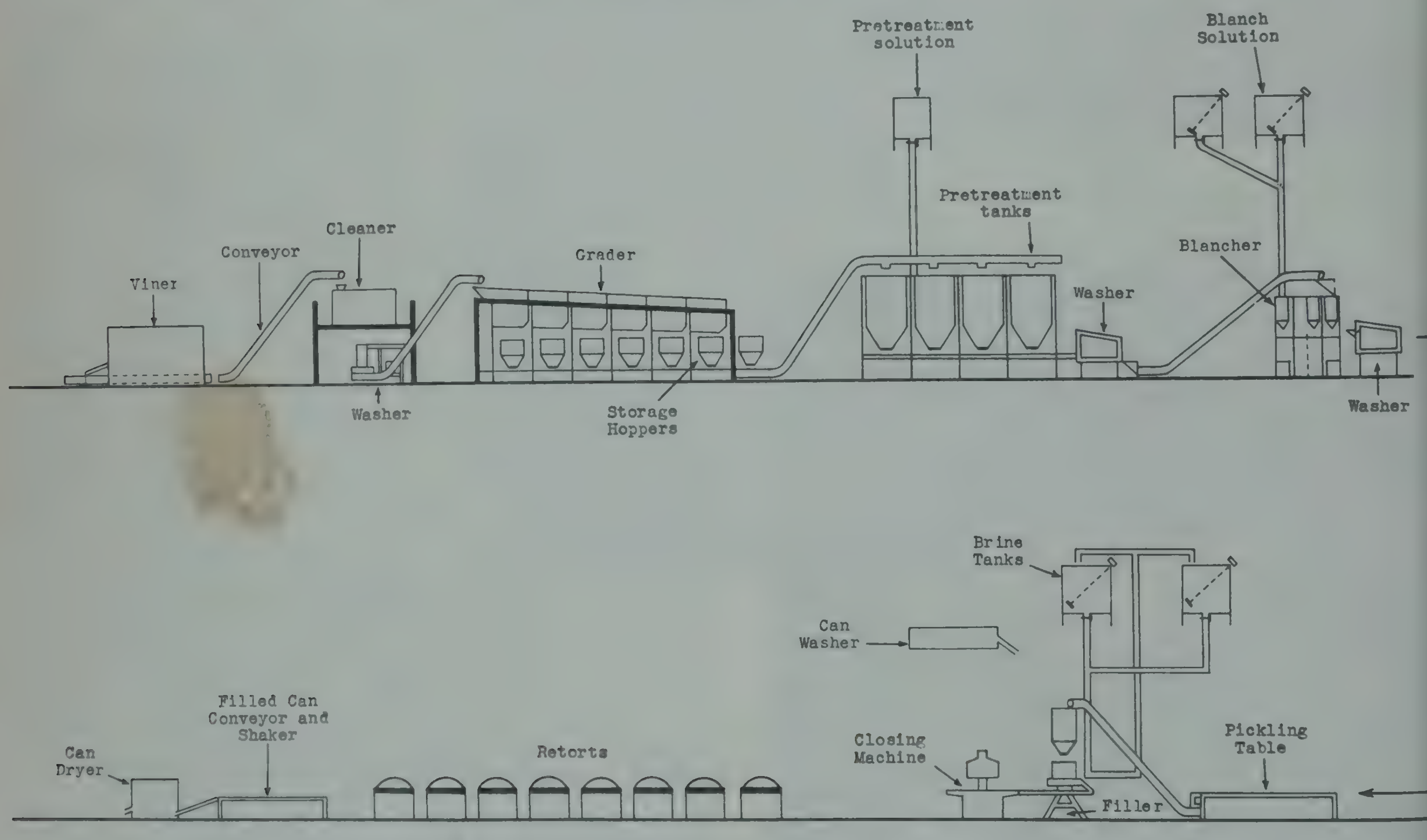


Fig. 4. Blair pea flow sheet.

a) a pre - treatment in 0.19 M sodium carbonate solution at 70°F for a period of thirt minutes. During this operation, the pH level of the peas is raised from a normal value of about 6.6 to about 7.8 to 8.1;

b) the pre - treated peas, following rinsing, are blanched in a very dilute solution of calcium hydroxide (0.005 M) at a time and temperature long enough to inactivate the enzyme systems in the raw product. Use of the calcium hydroxide solution maintains the alkaline reserve and also replaces calcium lost during the pre treatment, thereby preventing mushiness. A unique feature of the Blair procedure which results in a certain degree of quality improvement is that each lot of peas is blanched in fresh blanch solution;

c) the blanched peas, after rinsing, are filled into the container, and a " brine " consisting of a suspension of magnesium hydroxide (0.020-0.025 M) in a solution of salt and sugar is added. The containers are then sterilized. A special feature of the Blair procedure is the application of a highe

temperature for a shorter time than that usually employed. The process is equivalent in sterilizing value to the conventional heat treatment, but the detrimental effect on color and flavor is less marked. The process recommended in the Blair procedure for No. 303 cans is one of seven minutes duration at 260°F, followed by a rapid water cool to an average temperature of 70°F. Recommended storage temperature is 55°F or lower.

The improvement in the color is not the only benefit derived from the alkalinizing process. It has been established by correlating the responses of a large number of observers that the taste of Blair peas is a closer approach to that of fresh cooked peas than is the flavor of conventionally canned peas. The retention of nutritive values in Blair peas is essentially the same as in those packed by the standard method.

Blair peas have been packed commercially for over years, and it is expected that the procedure will gradually be used by more canners.

4. Dry whole milk

Dry whole milk is not a new product, but its quality has been greatly improved through wartime research, including packaging studies. The vacuum gas method is employed to retard randidity, and reasonable shelf life can be expected when air is removed to the extent that the intersticial space contains less than two per cent oxygen seven days after packing.

COULTER and JENNESS (11) have discussed in detail the packing of dry whole milk in inert gas. Their studies indicate that the gradual increase in the oxygen content of the headspace gases in the first few days after packing is due to desorption of oxygen from the milk particles and is roughly proportional to the total volume of adsorbed air on the powder particles. The amount of entrapped air is a function of the method of drying and the holding period prior to canning.

Difficulty in eliminating air is encountered because the walls of the air cells are highly concentrated lactose syrup (glass) which is relatively impermeable to gases. When the can is evacuated, oxygen diffuses slowly from the gas cells in the powder particles until equilibrium is attained. The rate is characteristic for each powder. COULTER and JENNESS also showed that holding the powder under high vacuum for long periods (20 hours) and regassing is an effective method of lowering the oxygen level.

Commercially, the dry whole milk is held for approximately 48 hours while fat is determined and bacteriological checks are made. At some plants the product is held under vacuum or in an inert gas atmosphere. The powder is then filled, at atmospheric pressure or under vacuum, into cans and covers are clinched on, or, if vent-hole cans are employed, the covers are double seamed to the cans. From 12 to 40 cans, depending upon size, are placed on trays which are in turn transferred to vacuum chambers.

In the vacuum boxes, vacuum is increased gradually to prevent the powder from exploding out of clinched seams or vent-holes. After maximum vacuum has been reached, usually in about 30 seconds, it is held for a few seconds and then dissipated with nitrogen or a mixture of nitrogen and carbon dioxide. The cans are then removed and double seamed or tipped with solder. A good technique will produce a headspace gas of less than 0.5 per cent oxygen in an empty can run as a control. Since the nitrogen itself may contain up to 0.3 per cent oxygen, removal of air from the free space during vacuumizing is obviously almost complete. As stated previously, oxygen is gradually desorbed from milk particles but should not exceed two per cent of interstitial volume seven days after packing if good quality is to be maintained during storage.

5. Dried eggs

The egg dehydration industry has been well established in the United States for at least 30 years, but until World War II, the volume of production was relatively small. As was the case with dry whole milk, dried eggs were greatly improved as a result of wartime research on production and packaging (12). Briefly summarized, the results of rather comprehensive studies on dried whole egg products showed :

a) that the stability of whole egg powder increases as the moisture content decreases;

b) that vacuum-gas packing with carbon dioxide or a 20 per cent carbon dioxide - 80 per cent nitrogen mixture is highly desirable and

c) that acidification to a pH of 5.5 before drying, followed by addition to the dry powder of the equivalent amount of dry sodium bicarbonate is highly efficacious.

The vacuum-gas cycle employed with dried eggs is very similar to that used with dry whole milk. Carbon dioxide is very soluble in the egg fat, so much so that if used undiluted the resulting vacuum would cause panelling of the can bodies. Accordingly, a mixture of nitrogen and carbon dioxide is used. Oxygen content in dried eggs is less critical than for milk, and a technique is considered satisfactory which will produce less than two per cent oxygen in an empty can used as a control.

Unlike dry milk, dried eggs do not desorb oxygen, probably due to greater permeability of the egg particles. However, proper degassing of filled containers is a problem principally because of the difficulty of evacuating gases through the packed powder.

6. Pressure-propelled products

During World War II over 30,000,000 aerosol "bombs" were used to disperse insecticides. They contained a mixture of about 80 per cent Freon (CCl_2F_2 boiling point - 12°F) and 20 per cent insecticide. When the valve was opened the tremendous increase in volume that occurred as the propellant changed from the liquid to the gaseous phase dispensed the insecticide into the atmosphere in the from of a very fine mist.

The first bombs were of the " high-pressure "type, consisting of two steel shells welded or brazed together and to which a dispensing valve was attached. After the war the bombs sold quite well for a while, but the container was very expensive in relation to the contents. The act that really launched a new industry was the amendment of the Interstate Commerce Commission regulations to permit shipment of "low-pressure" containers which would withstand 40 p.s.i. at 70°F. Such containers could be made from inexpensive materials on modern high speed can making lines.

The cans which are used for " low-pressure " bombs are adaptations of seamless drawn beer cans and soldered beer can bodies with special concave ends. The dispensing valves are usually made of rubber, stainless steel, and/or plastic.

Most of the first products packaged were true "aerosols" but the character of many of the items now dispensed makes it more appropriate to call them pressure - propelled products. They include such items as whipped cream, shaving soap, air deodorants, fire extinguisher fluids, waxes, water repellants, lacquers, pharmaceuticals, cosmetics, as well as insecticides. As far as food products are concerned, possible presurizing of salad dressing, mayonnaise, marshmallow, meringue, pancake batter, catsup, mustard, and chocolate syrup has been mentioned (13).

Selection of the proper propellant is important. From vapor pressure tables it is possible to choose that mixture of low boiling and high boiling liquids which will give the desired pressure. However, the propellant must also act as a solvent for or solute in the material to be dispensed but not react with it or the container.

Before filling the containers, the product and propellant are both cooled below 0°F so that there will be little loss of gas. After filling and insertion of the valve, the pressure inside the container remains essentially constant as long as the propellant remains.

II. OBJECTIVE METHODS OF RAW PRODUCT EVALUATION

Canners in the United States are fully cognizant of the part the raw food plays in obtaining high quality canned products. Over the past 12 years there has been an increasing use of objective methods in evaluating raw products, both as a guide to the payment of the grower and the segregation of products into lots for quality control purposes. A few of these methods which have received considerable attention are described.

One of the best known and most successful devices developed for grading peas is the Tenderometer (14), shown in figure 5. This machine measures the force required to press a sample of peas through a standard grid; the force necessary to shear the peas being directly proportional to toughness and inversely proportional to tenderness.

The sensitivity of the Tenderometer is shown by the curves in figure 6 which illustrate changes in tenderness with increasing maturity of the peas. In this instance the peas were harvested on three successive days from the same planting. Each value plotted in the curves represents the average obtained from Tenderometer determination on eleven different samples of peas. Numerous other studies have been made to correlate Tenderometer values with other methods of grading peas.

In the years since its announcement the Tenderometer principle has been extended to a number of products, although not with the acceptance achieved in grading peas (15). Recently a portable "miniature Tenderometer" has been constructed (16).

A number of methods of evaluating the optimum maturity of sweet corn have been devised in the attempt to improve upon the crude but rather effective test in which the fieldman forces his thumb into the kernels and judges maturity by the amount of milk which spurts and the appearance of the crushed kernels. Most of these have involved the direct or indirect measurement of the moisture content.

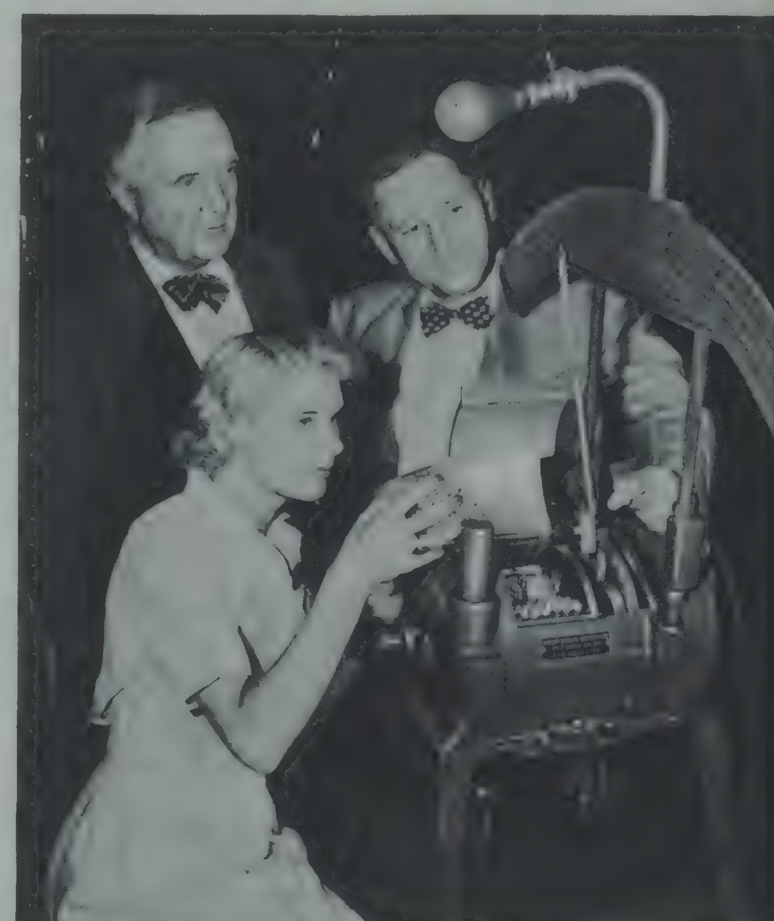
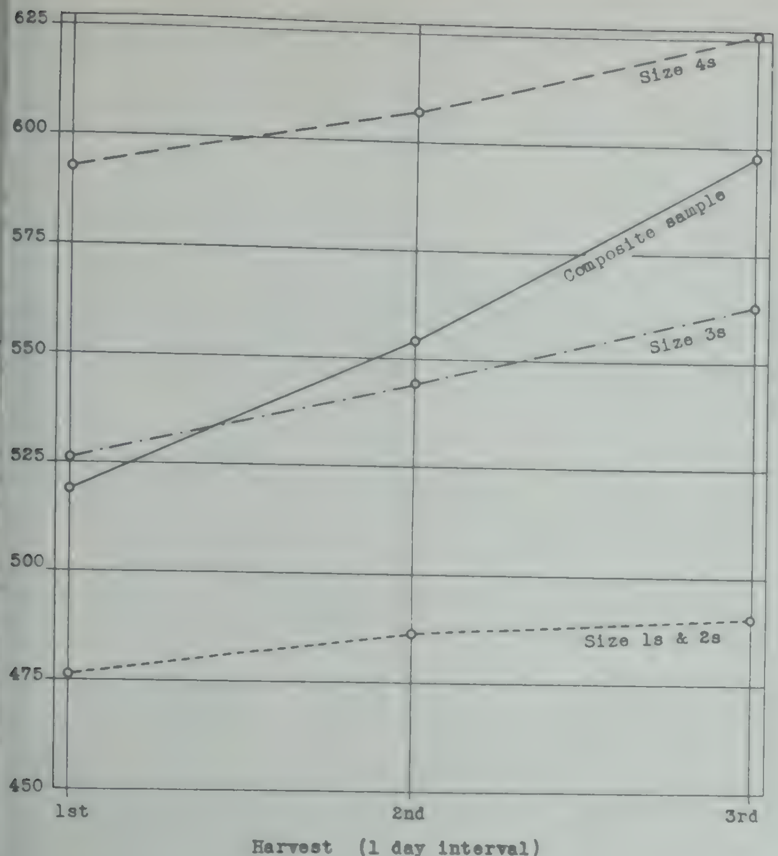


Fig. 5. Tenderometer. Determining tenderness of peas.

One method, developed during the war, used the refractive index of the expressed juice as a guide to maturity (17). A whole kernel cutter is used to remove the corn from the cob. The kernels are then ground in a Universal food chopper. The liquid which separates is absorbed in cotton and then expressed over the filling holes of the refractometer prisms.

It is essential to prepare calibration curves for each variety of sweet corn. This is done by determining both refractive index and moisture (or some other indication of maturity) on a large number of samples of varying maturity and then relating the two statistically or graphically. Preparation of such charts using the Brown-Duvel moisture results in per cent as a maturity index has been found desirable. A special refractometer with prisms of small range and large area is also used. Since the liquid is not transparent, the prisms must be set close together to permit sufficient light to pass.



ig. 6. Change in tenderness of peas harvested on three successive days as indicated by tenderometric readings.

The Succulometer (18) is also used in evaluating the maturity of sweet corn. In this method kernels are cut from the cob with a whole grain cutter, care being taken not to cut too deeply, corn to any external source of moisture. One hundred grams are placed in a chamber of the instrument, which resembles a horizontal cider press. A pressure of 500 lbs per square inch is then applied for three minutes and the volume of expressed liquid is measured. The Succulometer has also been used in evaluating the quality of canned corn. Table I shows the correlation between Succulometer readings, moisture determinations, and alcohol insoluble solids determinations.

The newest method, and one which is receiving increased acceptance, involves electronic measurement of moisture content (19). Detailed information is to be published in the near future comparing results obtained with this new rapid procedure and with the longer better-known methods.

It is claimed that a moisture determination can be made in five minutes using the new method. A weighed quantity of corn is placed in a definite volume of solvent of known dielectric constant. The solvent extracts the water from the solids. The mixture is then filtered and the clear liquid introduced into a high frequency oscillating circuit cell where the impedance of the solution is measured. The percentage of moisture is then read from a conversion chart.

The effect of water upon the dielectric properties of a solvent has been employed previously in determining the moisture content of seeds, and it appears that its use may be extended to determining the moisture content of other products for canning.

A Consistometer has been developed for evaluating the rheological properties of cream style corn at the cut-out stage (20). In this apparatus the area to which the product spreads in a fixed ime is measured. It has also been used to determine the consistency of applesauce, jellies, thick soup, etc....

Instruments for the evaluation of toughness in asparagus due to presence of fibre have also been eveloped. One employs a supported wire of definite diameter which is forced against the stalk (21). The istance from the blossom end at which toughness appears provides an index of quality. The other method s an adaptation of the fruit pressure tester in which maturity is determined by the penetration of a plunger ith a stainless steel puncturing tip (16).

TABLE I

RELATIVE SUCCULOMETER, MOISTURE, AND ALCOHOL INSOLUBLE SOLIDS VALUES FOR RAW AND CANNED WHOLE KERNEL BRINE PACKED GOLDEN SWEET CORN (18)

Canned kernels		Raw kernels		
A.I.S.	Succulometer	Moisture	Succulometer	Maturity rating per A.I.S.
15.0	23.7	77.9	25.0	Very young (fancy)
16.0	22.9	76.0	24.5	Very young (fancy)
17.0	22.0	74.4	23.8	Very young (fancy)
18.0	21.1	73.0	23.1	Very young (fancy)
19.0	20.2	71.7	22.4	Very young (fancy)
20.0	19.3	70.4	21.7	Young (extra standard)
21.0	18.4	69.0	21.0	Young (extra standard)
22.0	17.4	67.6	20.2	Young (extra standard)
23.0	16.5	66.3	19.0	Young (extra standard)
24.0	15.6	65.1	17.5	Nearly mature (standard)
25.0	14.6	64.0	15.9	Nearly mature (standard)
26.0	13.7	63.0	14.1	Nearly mature (standard)
27.0	12.8	62.0	12.4	Nearly mature (standard)
28.0	12.0	61.0	10.7	Mature
29.0	11.2	60.1	9.1	Mature

III. NEW TECHNIQUES

During the last 12 years several new closure techniques have been developed.

1. Steam-flow closing machines

Steam-flow closing machines were developed in the forties to replace space-consuming exhaust boxes (22). In the steam-flow closure technique, steam is jetted into the headspace of the can immediately before and during the assembly of the can and cover to displace the air in the headspace. When the steam condenses, a vacuum is formed. Since a steam-flow closing machine occupies no more floor space than a regular closing unit and eliminates the exhaust box, its use permits a considerable savings in space. Furthermore, the amount of steam consumed is much less than with an exhaust box.

Although the steam-flow principle is simple, a great deal of development work was required to design units which would consistently produce the desired vacuum in all of the cans under varying operating conditions. It was found that condensation of steam occurred very rapidly in cans filled with cold free-flowing liquids. Steam jets had to be located not only to place steam in the headspace, but also in such a manner as to make sure that the steam was not condensed and replaced by air before the seaming was completed.

The principal requirements in using steam-flow closure are that the food be prepared in such a manner that excessive air or gas is not left in the product, that the steam be able to sweep the air from around individual pieces of food projecting into the headspace above the packing liquid, and that the nature of the product be such that the headspace can be controlled.

With regard to the latter requirement, headspace control merits special comment. Steam-flow closure depends upon condensation of steam in the headspace zone to form a vacuum. Thus, failure to maintain a significant headspace at the time of closure will result in cans with low vacuums.

Subject to the above qualifications, the vegetables which may be packed satisfactorily with steam flow closure include carrots, beets, brine-packed whole kernel corn, tomatoes, and asparagus. Steam-flow could also be used for peas, green beans, and cream style corn, but there is no particular advantage.

Marine products and specialty items may or may not be closed successfully with steam-flow depending upon the nature of the individual product. When an item is of such character that the exposed surface is rough, or affords serious obstruction to the flow of steam in the headspace zone, a reduced efficiency of steam-flow closure must be expected.

2. Steam-flow combined with vacuum syruper

Although some fruits are successfully packed using steam-flow closure alone, the preferred method is in combination with a vacuum syruper. The vacuum syruper was developed to facilitate the packing of cold filled fruits (22). In this procedure the pieces of fruit are filled into the cans cold. The cans then pass to the vacuum syruping unit where they are vacuumized to remove entrapped air and intercellular gases Next, the vacuum is released with syrup to fill the interstices between the product and the can, and to provide a definite headspace.

For a number of years the cans were sealed in a vacuum closing machine in tandem with a vacuum syruper. However, since the steam-flow closure unit is smaller, less expensive, and will give the desired vacuum equally well, it has largely replaced the vacuum closing machine except on items when accurate control of headspace is difficult.

3. Gas-flow closure

Gas flow closure was mentioned previously in connection with the canning of beer. In this procedur an inert gas, or mixture of gases, is jetted into the headspace of the can immediately before and/or durin the assembly of can and cover to displace the air in the headspace. Since the gas does not condense as doe steam in the steam-flow process, the design and placement of jets is not as critical as is the case wit steam-flow machine, but the unit must be designed to avoid excessive use of gas.

The principal use for gas flow closure is in the packing of beer. The procedure is also employed t sweep air from the headspace of enameled cans packed with orange juice, thus preventing softening and los of adhesion of the enamel. The discoloration of canned cranberry sauce is also prevented by gas flow closur

In general, carbon dioxide is more soluble in the product than nitrogen, and upon being absorbe into the product, forms a vacuum in the can. Vacuum in the can may, therefore, be controlled to a certai extent by selecting the composition of gas that will be used, varying the ratio of carbon dioxide to nitroge depending upon the vacuum desired in the can.

4. Vacuum packing

Although the idea of vacuum packing is now more than 50 years old, the procedure is being extend each year to retain the freshness of additional products, particularly foods containing readily oxidizab

lpoids. Quality deterioration caused by the development of rancid odors and flavors is inhibited quite well y eliminating from the sealed container the air necessary for oxidation.

The canning of succulent vegetables by the vacuum pack method has had a steady growth since 1928. arge percentages of the whole kernel corn and sweet potato packs are of the vacuum style, as well as smaller uantities of peas, green beans, carrots, and beets.

Creation of a high vacuum in the can makes it possible to add only a little or no brine, and to fill he food cold. In the absence of the fixed gases, the moisture vaporizes during the process and transfers eat to the food particles. Heat transfer in vacuum packed products is described in more detail later in iscussing the agitating-vacuum process.

Vacuum packing favors the retention of the water soluble minerals and vitamins present. In brine acked products considerable extraction occurs, and it is a common practice to discard the liquid after the egetables have been heated prior to serving. There is less extraction of minerals and vitamins in the small mount of brine added to vacuum packed products; furthermore, this small volume of liquid is usually served ith the solid portion, thus conserving the nutritive values.

5. Vacuum-gas packing

Vacuum-gas packing, commonly called " gas-packing ", was mentioned earlier in connection with the anning of dry whole milk and dried eggs. Briefly summarized, the method consists of placing in a chamber he filled cans with clinched covers or vent-hole covers, removing the atmospheric gases from the filled ontainers by vacuumization, dissipating the vacuum with an inert gas, removing the cans from the chamber, nd hermetically sealing the containers (23). Vacuum-gas packing, therefore, is merely the replacement of he air in a hermetic container with an inert gas.

The vacuum packing method of obtaining low oxygen tension in dry food materials is limited to conainers of a size and shape capable of withstanding the pressure of the atmosphere. The use of vacuum-gas acking eliminates the danger of container distortion by substituting inert gas for vacuum, thus balancing he external pressure. The limit on the size of containers which may be employed for gas packing is determined nly by the means of handling them and making them hermetic following gassing.

The vacuum-gas packing method is not without disasvantages. First, the speed of handling is genelally reduced over straight atmospheric or vacuum packing operations. Second, equipment and labor costs, hen packing by this method, tend to be higher than for vacuum or normal closure. The cost of the gas is sually not a major factor in the added cost.

A partial list of products which retain their normal characteristics to a better degree when vacuumas packed includes dry milk, dried eggs, nut meats, Chinese noodles, potato sticks, and other dehydrated roducts. Cereals, flours, popcorn, and other prodcts of this nature have also been vacuum-gas packed o impede the life cycle in cases of insect infesation.

V. NEW STERILIZING PROCEDURES

Food quality is a composite of a number f factors including appearance, texture, flavor, nd nutritive value. Loss of quality through hemical reaction is a function of temperature and ime, and the rate of reaction is approximately oubled for an 18°F increase in temperature. Accordingly, the sterilizing operation has the greatest ffect upon the quality of a canned product.

JACKSON and BENJAMIN (24) have used lata reported by GREENWOOD et al. (25) to show that the rate of loss of quality at high processing temperatures is less than the rate of destruction of typical food spoilage bacteria. In figure 7 are plotted the relationship of time and temperature to both loss of the heat labile vitamin, thiamine, and destruction of spores. The thermal death time (TDT) curve expresses combinations of time and temperature which are equally effective in destroying bacteria when no significant time is involved in heating to, or cooling from, the lethal temperature.

It is obvious from the graph that the destruction of microorganisms and the retention of quality (thiamine) can be best obtained by the use of high processing temperatures. BALL (26) has called high temperature short time sterilizing operations "high-short" processing.

Much of the research on quality improvement in the last 12 years has concerned " high-short " processing and attempts to increase the rates of heating and cooling of the product, thus reducing the time during which it is subjected to heat.

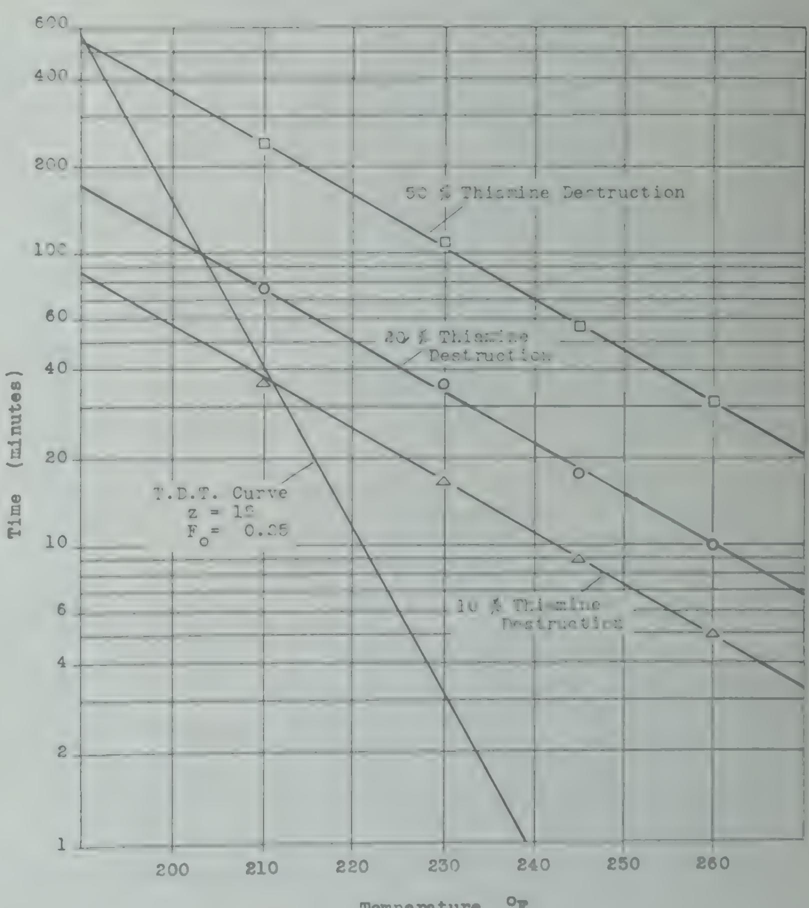


Fig. 7. Effect of temperature and rates of destruction of thiamine and typical bacterial spores.

I. Presterilization procedures

Application of the "high-short" principle of food sterilization to hermetic containers of practical dimensions is complicated by the lag in penetration of heat to the center of the food, particularly in viscous foods which heat mainly by conduction. Effective application requires nearly uniform and rapid heating of the entire portion of food to accomplish sterilization within a few minutes or preferably within a few seconds.

The procedure which is usually applied to fluid or semi-fluid products depends on presterilization of the food in a heat exchanger prior to filling into the container. This method may be applied to either acid or low acid products. The acid product, such as fruit juices, may be sterilized at temperatures below 212°F. and filled hot into non sterilized cans; the heat of the product is expected to destroy spoilage bacteria which may reenter the product during filling and closing.

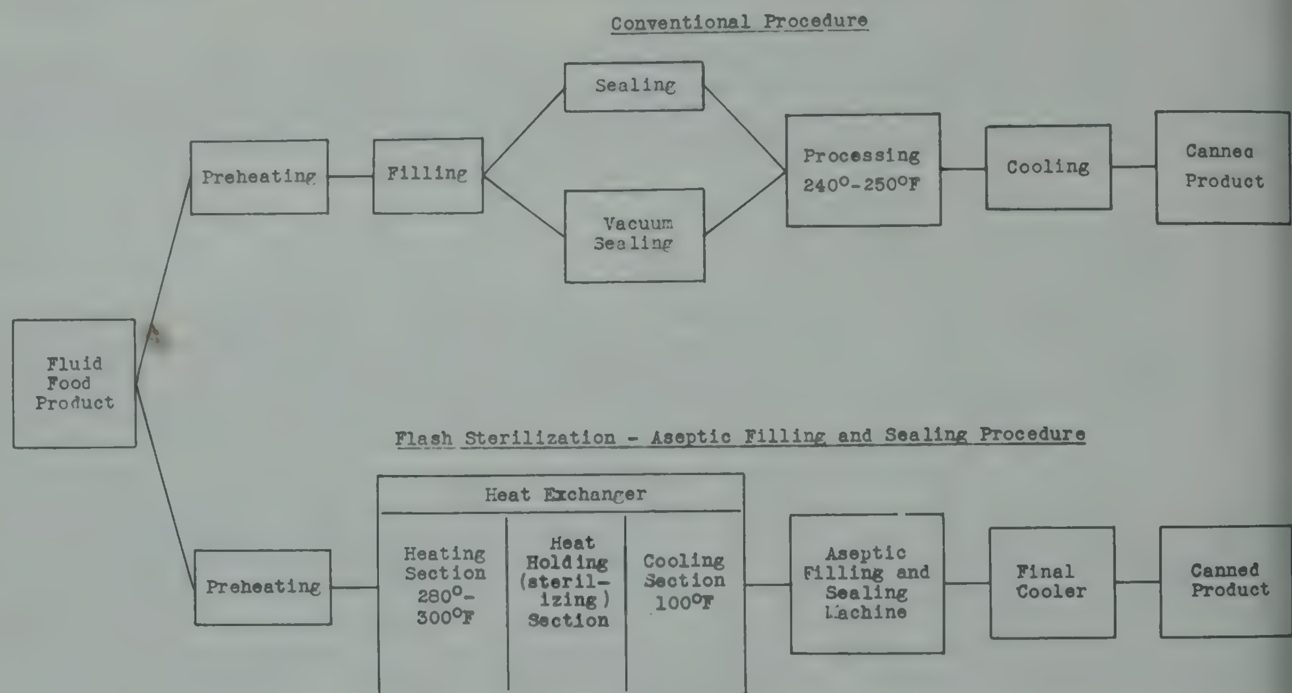


Fig. 8. Conventional and flash sterilization aseptic filling and sealing procedures for low acid fluid food products.

The low acid products, such as vegetable purees and dairy products, must be heated rapidly to temperatures in the range of 260° to 300°F to effect sterilization in an interval of a few seconds. Sterilization is followed by rapid cooling in a heat exchanger to stop the destructive action of the heat as soon as possible. The sterilized food then must be filled and sealed in presterilized containers under aseptic conditions because certain air or equipment-borne microorganisms capable of growth in low acid products are not destroyed readily at temperatures slightly below 212°F. Final cooling of the sealed container is ordinarily required before storing. Diagrammatic representation of this procedure appears in figure 8.

The superior thiamine retention obtained by experimental application of this procedure to cream style corn is exemplified in figure 9. The vitamin assay data are from the product canned in 12 oz. metal cans.

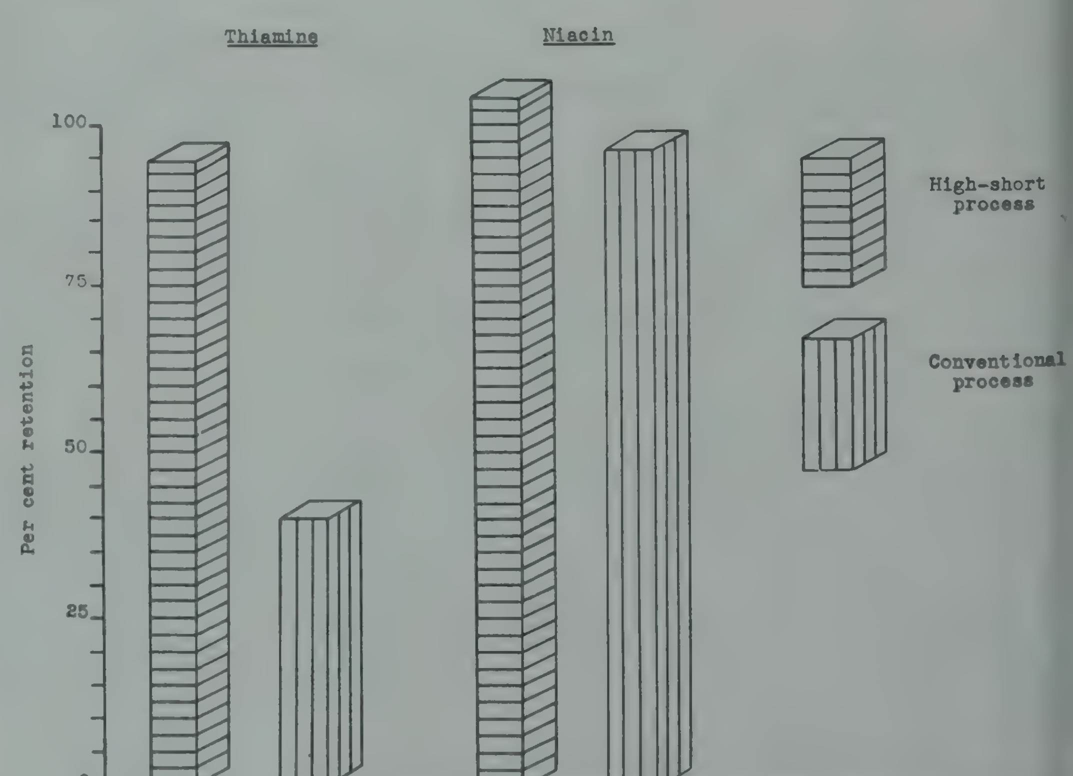


Fig. 9. Effects of high-short and conventional processing on certain vitamins in cream style yellow corn.

A number of engineering problems are involved both in the presterilization and in the filling, sealing, and cooling operations for either acid or low acid products. Both tubular and plate types of heat exchangers may be used for the acid products with either steam or water on the hot side of the exchanger. In either case the area of heat exchange surface required must be calculated from applicable heat transfer data; adequate allowance must be made for reduction in heat transfer by the coating of the exchange surface with solids from the food product.

The higher temperatures required for sterilization of low acid foods precludes the use of availabl

late type exchangers. Tubular exchangers impose requirements for high pumping pressures in order to obtain he turbulence required for good heat transfer and to minimize the coating of exchange surfaces at high tempeatures.

Piston type positive displacement pumps, of the same kind employed in milk homogenizers, are used ost commonly. They are designed to pump against a pressure of several thousand pounds per square inch. To educe the pulsations, the pumps are generally made triplex in character, the pistons operating 120° apart.

Recent work in this laboratory has indicated that a revolving scraper within a tube type of heat xchanger will help to overcome the turbulence and coating problems. This equipment employs scraper blades ounted on a revolving mutator shaft in a steam or water jacketed tube. The product is pumped at relatively ow pressure through the annular space between the mutator and the tube. Rotation of the scraper blades rovides mechanical turbulence and maintains the heat exchanger surface relatively free of film.

Heating by direct steam injection involves a number of problems, such as cleanliness of steam and ontrol of solids content in the product. However, this procedure is applicable to some processes, especially n the dairy field.

2. Presterilization of tomato juice

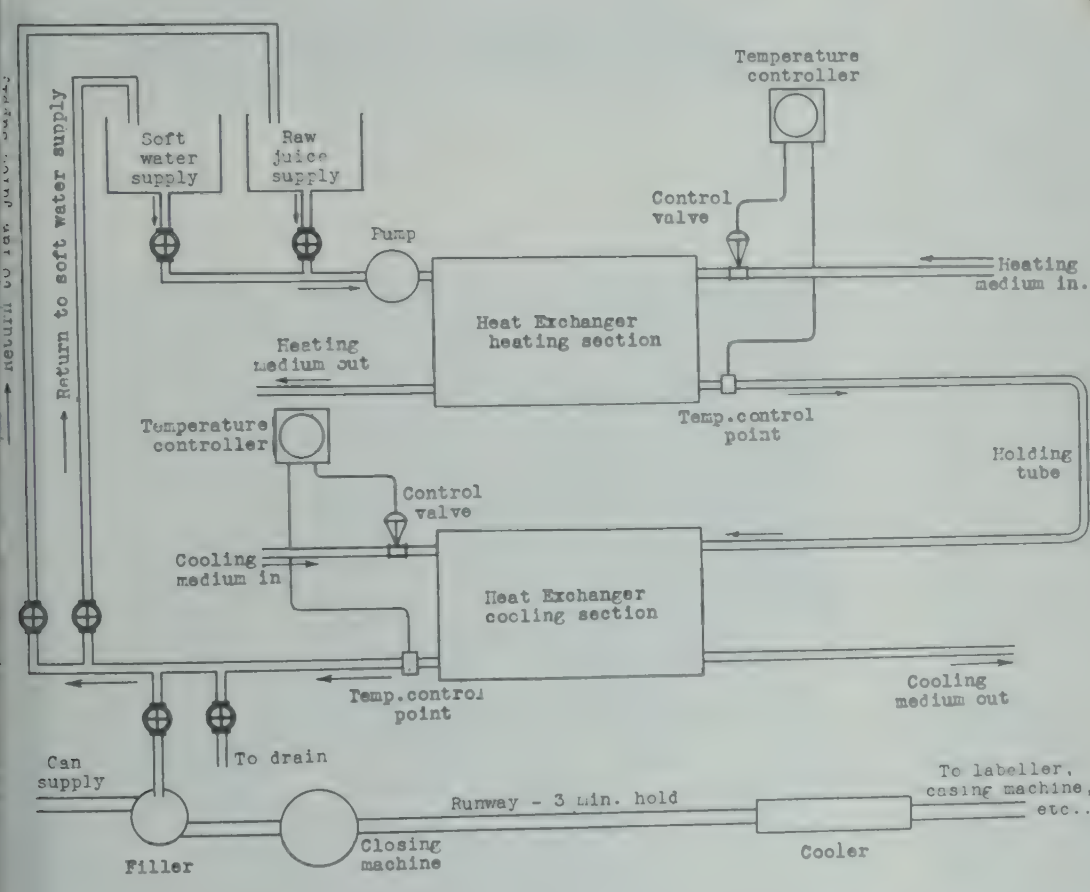


Fig. 10. Flow diagram for presterilization of tomato juice.

Tomato juice and tomato-vegetable juice mixtures present an interesting special case. Although these are acid foods, they support growth of the moderately heat resistant and acid tolerant organism <u>B. thermoacidurans</u> (27) and <u>Cl. pasteurianum</u> (28) which are not destroyed by conventional retort process. It is possible to destroy the organisms by using a presterilizing procedure, usually holding the juice at 250°F for approximately 0.7 minute, then cooling to approximalety 190°F for hot filling, sealing, and subsequent cooling. This filling and sealing procedure, of course, is predicated on the assumption that contamination with these resistant organisms will not occur in the filling and sealing operations (29, 30). A flow diagram is shown in figure 10.

In 1941 there were a number of large outbreaks of flat sour spoilage in canned tomato juice. It is significant that no spoilage was encountered in juice processed in presterilizers properly operated at recommended temperatures. This experience accelerated the trend to the use of " flash " sterilization.

3. Aseptic filling and sealing

The aseptic filling and sealing of the sterilized product in presterilized containers presents a difficult engineering problem which has been approached commercially in two different ways.

One, procedure, used in the commercial canning of an improved chocolate milk drink, involves filling and sealing the presterilized containers in an atmosphere of live steam confined in an enclosed chamber. Rotary sealing valves are used to admit empty containers to high pressure steam sterilizing chambers, to transfer the sterilized containers to the filling and sealing chamber maintained at a lower pressure, and to discharge the filled and sealed containers (31). The problems involved in this procedure are largely mechanical, encompassing the operation and lubrication of conveying, filling, and sealing equipment inside of the closed chambers. Maintenance of high pressure steam in the container sterilizing chambers and low pressure steam in the filling and sealing chambers involves well standardized steam engineering and instrumentation. A commercial aseptic filling and closing machine for metal cans is illustrated in figure 11, (p. 12).

In February 1951 the canning of pea soup was undertaken using a second type of aseptic filling and closing unit. Sterilization of product is accomplished in a tubular heat exchanger. Cans and covers are sterilized in superheated steam at atmospheric pressure. Aseptic filling of the cold sterile product into the sterile containers and sealing of covers is also achieved in an atmosphere of either saturated or superheated steam (32, 33).

The outward flow of superheated steam apparently effectively prevents air-borne bacteria fom entering the system through the entrance, exit, or other openings in the equipment. This counter-current principle not only makes un-necessary mechanical valves for passing the empty containers and covers in, and sealed containers out, but also eliminates the necessity for pressurized equipment. This type of aseptic unit is considerably cheaper and requires less floor space than the style that employs steam under pressure.

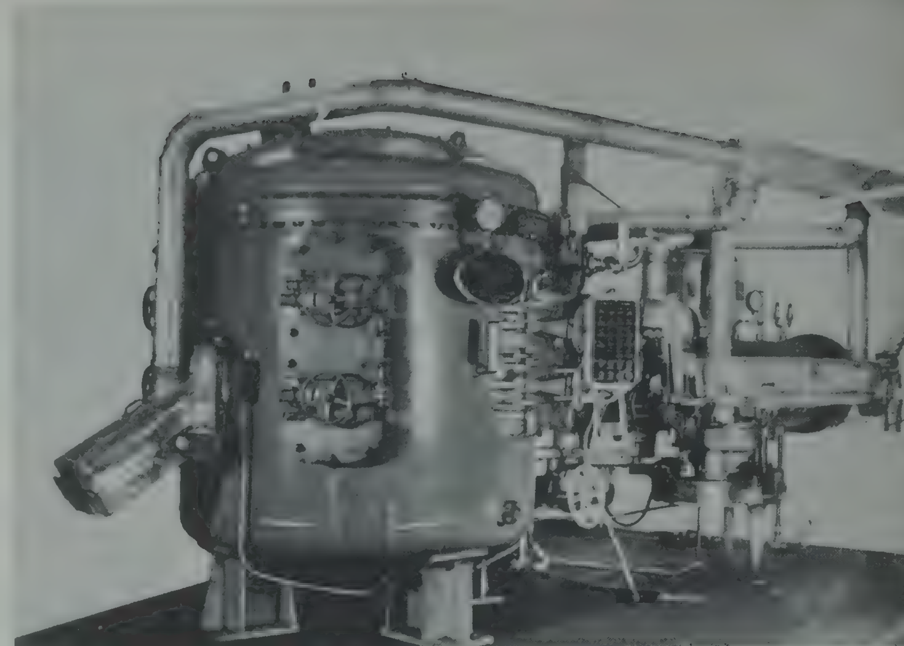


Fig. 11. Commercial aseptic filling and closing machine.

4. Agitating-vacuum process

Sterilizing retorts which contain a cage or framework for supporting and revolving cans during the heating cycle have been used for a number of years especially in the evaporated milk industry. A small retort is shown in figure 12. Recently, canned vegetables with improved color, flavor, and nutritive value have been obtained by using these retorts to process vacuum packed products (34). A marked increase in the heat penetration rate makes possible a reduction in sterilizing times.

The heat transfer principle involved in the processing of vacuum packed vegetables is rather interesting (35). In such products voids exist between the individual particles of food due to the small amount of brine used. Transfer of heat in the conventional still process occurs as previously described through the vaporization and condensation of the small amount of the brine in the can. Use of a high vacuum permits ready vaporization at low temperature. The warm vapor then circulates through the can and condenses, giving up its heat to the cooler food particles. The condensate in turn flows to the hot surface of the can and there completes the cycle by reconversion to the vapor phase.

As the temperature inside the can increases, the rate of heat transfer becomes progressively slower, so much so that longer processes are required for vacuum packed products than for the same foods in brine. The relatively long sterilizing time tends to offset the quality advantage obtained by using only a small amount of brine. It was suggested that accelerated heat transfer should be obtained if the hot vapor cycle, described above, were supplemented by a hot liquid cycle. This could be achieved if the cans were agitated in such a manner that the hot liquid would trickle over the food particles, lose its heat to the food particles and then become re-heated through contact with the hot walls of the can. Experiments showed that an amazingly rapid rate of heating resulted when vacuum packed corn was agitated during processing by either end-over-end or continuous axial rotation.

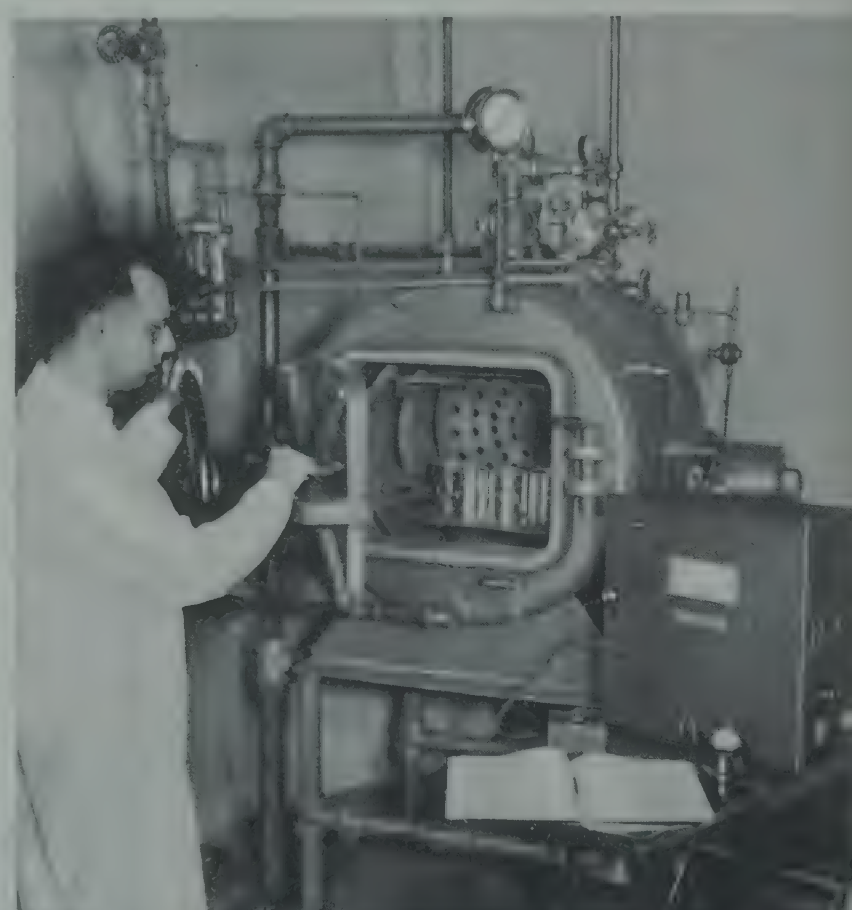


Fig. 12. Retort with rotating cage-determining heat penetration during rotation of cans.

The rate of heat penetration expressed in terms of equivalent process time for different types of can rotation and for vacuum packed peas ans corn is shown in table II (page 13).

The shorter sterilizing times which are made possible by agitation of vacuum packed cans during processing result in a striking improvement in the color and flavor of corn. This quality improvement is manifested also in the relative degree of retention of the heat labile vitamin thiamine. Thiamine retention data in vacuum packed corn subjected to bacteriologically equivalent still and agitating sterilizing are shown in figure 13 (page 13).

TABLE II

RELATIVE HEATING RATES IN VACUUM PACKED VEGETABLES AGITATED DURING PROCESSING - 307 x 400 CANS (34)

Product	Type agitation	Reel Speed R.P.M.	Sterilizing Value (+) F_0 Minutes	Calculated processing Time at 250°F Minutes
Sweet peas	End-over-end	23	7.4	9.6
	Continuous axial	23	7.4	9.9
	Intermittent axial	48	7.4	13.2
	Still	..	7.4	20.0
Corn	End-over-end	23	9.8	12.6
	Continuous axial	23	9.8	11.8
	Intermittent axial	48	9.8	14.0
	Still	..	9.8	35.0

(+) After Ball.

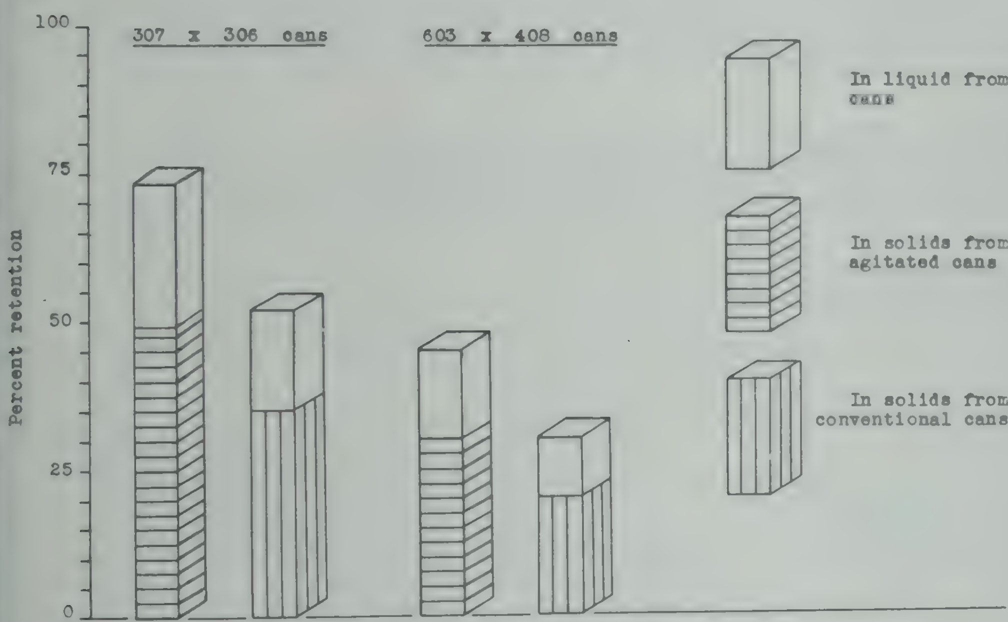


Fig. 13. Retention of thiamine in vacuum packed white corn sterilized by agitated can an convention methods.

5. Other agitation

Other applications of end-over-end rotation of certain canned foods during processing have been studied recently (36). Cans were rotated at a speed such that the centrifugal force acting upon the can approximates the force of gravity at the center of the can. Movement of the "headspace" in the cans caused an agitation of can contents. It is claimed that higher processing temperatures can be employed without scorching or overcooking, and that the shorter processing times result in improved quality.

6. New types of cream-style corn

Before devoting additional space to new procedures employed in canning corn, it might be well to state that in the United States corn is one of the large volume canned food products. Over 17 million cases of cream style corn were packed in 1949 and over 15 million cases of whole kernel corn.

Conventional cream style corn is prepared from corn removed from the cob by shallow cutting through the kernels and subsequent scraping, causing it to have a creamy consistency. As its name implies, whole kernel corn is made by cutting essentially whole kernels from the cob. The kernels can be washed to remove silk, bits of cob, and other extraneous matter.

In the last several years a " comminuted " cream style corn has been packed on an increasing scale (37). Kernels of corn are cut from the cob in the same manner as for whole kernel corn. They are washed and inspected and part of them are then comminuted to a creamy consistency. The remaining kernels may or may not be slit into smaller pieces. Finally the cream is blended with the slit or whole kernels. The proportion in which they are mixed depends upon the preference of the individual canner, but the kernels and sections of kernels usually comprise well over half of the product.

Work on comminuted corn led to the "Cremogevac" procedure for reducing the time required to sterilize certains foods products (38). Reduction of processing time is made possible by stratifying the product in such a manner that during sterilization heat transfer is more rapid than in the conventional cream style product.

Cremogevac corn is made from whole corn kernels, comminuted kernels, and brine as shown in figures 14 to 18 (page 14). The preferred method of packing is to place the comminuted kernels or cream component, which heat by conduction, in the cans first. This layer usually occupies less than a third of the can volume. On top is placed the mixture of brine and kernels which heats rapidly by convection. If the mean temperature of the three components is not high enough to provide a normal vacuum in the container after processing and cooling, or if the amount of brine used is insufficient to fill the interstices between the kernels, the

container must be vacuum closed; otherwise, standard closure is satisfactory. Immediately after sealing, the container is inverted, and, if the processing is done in a still retort, the container preferably remains in this inverted position during the sterilizing process.

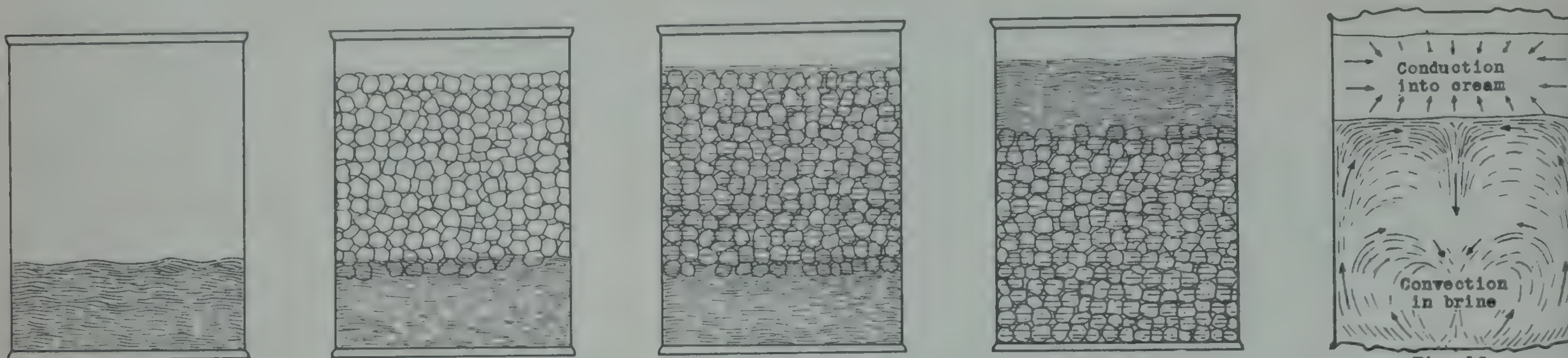


Fig. 14. Fig. 15. Fig. 16. Fig. 17. Fig. 18.

Fig. 14 to 18. Cremogenized corn diagrammatic sketch of filling and heating. Food Engineering.

Fig. 14. First, concentrated cream component is filled into can; Fig. 15. Then kernels are put into can on top of cream component; Fig. 16. Next, brine is added, filling space around kernels; Fig. 17. And sealed can is inverted for processing (desirable but not necessary); Fig. 18. Heat flows into product by convection and conduction.

During sterilization the temperature rises rapidly within the mass of kernels and brine. Since the layer of cream is rather thin, heat transfer to the center of the layer by conduction is obtained in a much shorter time than in the premixed conventional product. After processing, the cans must be agitated to mix the contents.

Equivalent processes for Cremogevac and conventional cream style corn have been published by those who developed the method. There are shown in table III.

TABLE III

EQUIVALENT PROCESSES FOR CREMOGEVAC AND CONVENTIONAL CREAM STYLE CORN (38)

Initial temperature	can	Cremogevac (Min. at 250°F)	Conventional (Min. at 250°F)
150	No. 1	33	52
	No. 2 Vac.	41	66
	No. 303	42	67
	No. 2 Stan.	46	74
70	No. 1	39	
	No. 2 Vac.	49	
	No. 303	50	
	No. 2 Stan.	55	
180	No. 1	30	46
	No. 2 Vac.	37	58
	No. 303	38	59
	No. 2 Stan.	41	64

Still another method of rapidly processing cream style corn at high temperatures has been devised (39). The new method permits agitation of contents in a continuous pressure cooker without curdling. Following the conventional practice of cutting and scraping the cobs, brine is added and then a specially formulated non-curdling starch. The amount of starch added may vary considerably depending upon the nature of the corn.

In using continuous pressure cookers for cream style, initial consistency, as contrasted with final consistency, is of the utmost importance. Initial consistency must be maintained below certain maximums to allow proper heat penetration and thus insure the effectiveness of the sterilization process. A special type of consistometer is required which correlates the initial consistency with the rate of heat penetration. Since the time the corn remains in the blending tank will also influence the consistency, another instrument is used immediately before filling to measure the consistency automatically and add water if required. Proper filling of cans is also essential for adequate sterilization since over-filled cans heat more slowly than those containing a normal amount of product.

Using the new procedure, white corn and yellow corn have been processed at 250°F in No. 2 and 303 cans for less than 15 minutes; by contrast, the conventional retort process is 70 minutes. As could be expected from such a reduction in sterilizing time, there is a major improvement in color and flavor of the product.

7. Radiations and antibiotics

PROCTOR (40) has recently summarized the many attemps to sterilize foods with little or no heat by application of various radiations.

Up to the present time sonic energy has not been found practicable although it appears to exert some lethal effect.

Radio frequency waves and infra - red radiations apparently have no significant bactericidal effect other than that resulting from the rapid production of heat.

Practically no heat is produced by irradiation with ultra-violet light, X rays. Ultra-violet light has a surface effect only. X rays exert a lethal effect on many of the common spoilage organisms. The X rays produced at high voltages, three megavolts or higher, have great penetrating power and show lethal effects on a wide variety of microorganisms including heat resistant spore formers. Due to the inefficient conversion of cathode rays to X rays at the target, it is not practical at present to use X rays from electric power sources in the sterilization of foods. The exposure times necessary to produce the roentgen dosages required to obtain complete destruction of organisms are too long, at least with presently available equipment. However, a much greater intensity of gamma radiation may be available from radio-active by-products of nuclear reactors. It is expected that increasing availability of these waste products will stimulate much more work in this field.

Cathode rays have been proved capable of destroying all microorganisms in foods. The electron beams can be produced at high intensities and sterilization is accomplished rapidly - usually in a few seconds or less. For a given energy the penetration however, is much less than with X rays, with present laboratory equipment, food sterilization is limited to layers less than an inch thick. More radiation energy is required to inactivate enzymes than is necessary for sterilization. Certain undesirable flavor and color changes have also been produced in some foods subject to irradiation by cathode rays. To the present time, these have not been explained or controlled. Further experimental work will be necessary before cathode ray irradiation can become a commercial method for canned food processing.

Late in 1949 the use of the antibiotic "subtilin" and mild heat was suggested for the preservation of certain canned foods now preserved by high temperature processing (41). Interest in the new method was stimulated by numerous releases in the trade journals. Subsequent work in this and other laboratories has proved that subtilin and mild heat cannot be relied upon for the destruction of spore of Cl. botulinum or the usual spoilage types in the low-acid canned foods which are preserved by high temperature sterilization (42, 43).

Subtilin does appear to be effective in inhibiting organisms responsible for flat sour spoilage in tomato juice. This observation, however, offers little promise of technological use, because if the antibiotic were used as a supplemental agent in the preservation of acid products, its employment would be only an insurance against unusual contamination by spoilage organisms. These are already controlled in regular canning operations.

Although results of the recent studies have contradicted the promising results reported by the original investigators, and the idea of using antibiotics raises many questions which would take a great deal of research to answer, most bacteriologists in the industry agree that it is desirable to conduct further research on the use of antibiotics in food processing.

IV. NEW CANNING EQUIPMENT

Great strides have been made in the mechanization of canning operations. Through the installation of new equipment, and the instrumentation of existing equipment, canners have been able to convert some operations to a fully automatic basis and other to a semi-automatic basis. This has usually led to higher line speeds and improved quality products.

Space will not permit discussion of the many pieces of new equipment which have been developed. Accordingly, only three items and a new method of cleaning raw foods are described.

I. High vacuum-low temperature evaporators

Several types of evaporators are now being employed in the production of frozen concentrated orange juice (44, 45, 46). One which is being used in both Florida and California is unique in that it utilizes both sides of a refrigerant compressor system - the heat pump principle (44, 47). Water is evaporated from the juice in one tubular heat exchanger with heat obtained by condensing compressed ammonia. The water vapor is then condensed in a second heat exchanger by evaporating liquid ammonia. This gives an approximately balanced system of high efficiency.

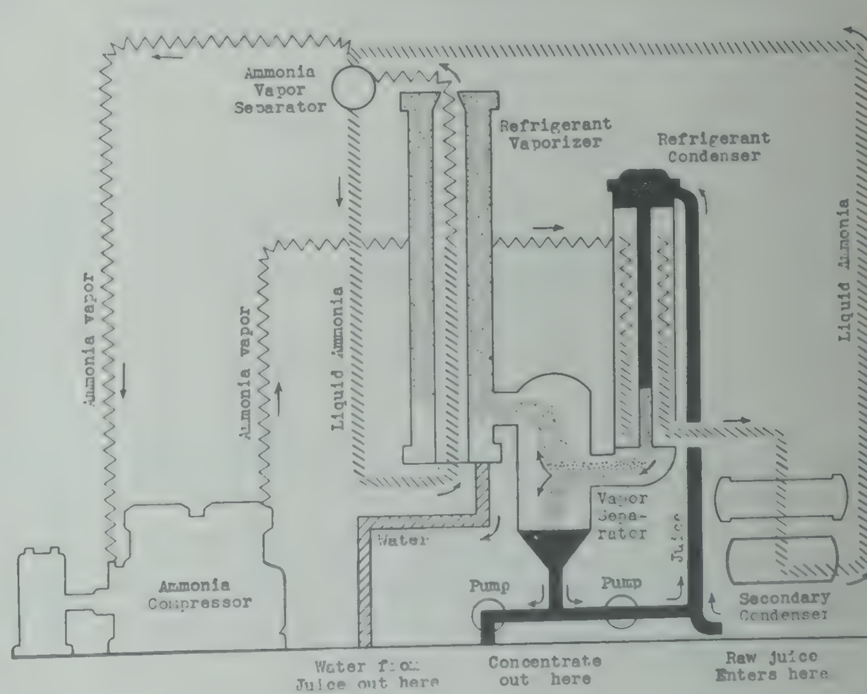


Fig. 19. Low temperature evaporator diagrammatic sketch of principle involved in Mojonnier apparatus. Western Canner and Packer.

A diagrammatic sketch of one stage of the evaporator is shown in figure 19. Raw juice is pumped to

the top of a vertical tubular heat exchanger. As the film of juice falls to the bottom of the tubes which are held under high vacuum, heat from the compression of ammonia vaporizes part of the water. This water vapor moves into a horizontal vapor separator and then into the condenser. This is a second vertical tubular heat exchanger. The water vapor is cooled by evaporating liquid ammonia through an expansion valve.

In this first stage the juice is concentrated from 8-13 per cent solids to approximately 20 per cent. It then overflows into a similar second stage evaporator where it is concentrated to about 40 per cent solids. In the third stage the solids are increased to approximately 60 per cent.

The low temperature of the compressed ammonia (105°F) eliminates the hazard of local overheating. Furthermore, no steam or outside source of heat is used. Power supplied to the compressors is the only source or energy.

2. Retort crate loader

The hydraulic retort crate loader and unloader, like the competitive magnetic and suction cup loaders, is designed to speed the careful and orderly loading and unloading of retort crates with a minimum of labor (48).

A loading table with a sheet steel top capable of holding about 100 No. 2 cans is placed at the end of the canning line. The containers are conveyed to this table from the closing machine. Built into the floor at the end of the table is a hydraulic lift having a circular platform slightly smaller in diameter than the removable bottom of a crate. As the cans accumulate, an empty crate is placed against the end of the table over the lift. The lift then raises the bottom of the crate and the operator pulls the cans onto the bottom with a strap. After the first layer is completed, the lift is lowered, another plate is placed on top of the first layer of cans, and a second layer is formed, etc... For unloading, the filled crate is placed over a similar hydraulic lift installed in the warehouse or casing area and operates in reverse, the operator pulling off one layer at a time with a strap.

3. Chemical and steam peeler

Efficient chemical and steam peeling machines have been developed in the last few years (49). Units are available for the peeling of products such as peaches, apricots, and tomatoes which coat the fruits with chemical, expose the coated fruit to superheated steam, and then wash off the disintegrated skin and chemical residue.

By varying the concentration of lye in the dip, and by controlling the wettability and viscosity of the lye bath with other additives, it is possible to carry into the steam chamber on the skin of the fruit, that quantity of chemical which is just sufficient to react with and consume the skin when activated by steam at 300°F. The time of exposure is of the order of 10 to 14 seconds.

Because of the ability to control independently the lye concentration and temperature, and the subsequent reaction temperature, this method is expected to be useful for peeling a wide variety of crops.

4. Froth flotation

The principle of froth flotation, used so successfully in recovering mineral from low grade ores, has recently been used to separate nightshade berries, splits, and general extraneous matter from peas (50). This principle of selective cleaning is based on the fact that impurities mentioned previously are not wetted by water but are entrapped in a frothy emulsion. The latter is made by forcing bubbles of air through water containing a mixture of oil and wetting and emulsifying agents. The foreign materials are carried to the top of the tank and are skimmed off while the peas are removed from the bottom of the tank. In addition to cleaning the peas, this method has been applied to the cleaning of other legumes such as Lima beans, soy beans and some types of berries.

A flotation method for cleaning cut kernels of corn is also employed but without the oil emulsion (51). In this method addition of a little ground raw corn causes the mixture to be self-frothing. The foam carries the hulls, silks, bits of husks, and other foreign material to the surface of the washing tank while the whole kernels sink and are removed from the bottom of the tank.

In this rather lengthy discussion we have attempted to show that important technical progress was made by the canning industry in the United States in the 14 years since the First International Canners Convention. As for the future, we think that it is extremely significant that every phase of the canning and manufacturing industries is rapidly expanding its research staff. Past experience with expanded research programs would indicate that an era of even greater technical progress lies ahead.

The authors wish to acknowledge the many helpful suggestions of their associates on the staff of the Research Department during the preparation of this paper.

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XV. TECHNICAL PROGRESS IN THE FRENCH CANNING INDUSTRY DURING THE LAST 10 YEARS

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Although during the last 10 years the French Food Canning Industry has, without doubt, evolved and developed considerably, no really new technique has been applied in the preparation of canned foods other than fish. In fact, in the field of French canned vegetables, fruits and meats, the only development which can be seen is the adoption of certain improvements in standard techniques and in an important increase in the means of production, by the installation of more and more highly mechanised continuous canning lines.

The efforts of the industry have, moreover, mostly been directed along the following lines :

- rationalisation of production;
- improvement in the hygiene of production;
- the choice of raw materials especially suitable for canning.

The effect of all these has been towards a reduction in the net cost and in the obtaining of high quality products both from the point of view of flavour and nutritive value.

Considering canned foods as a whole, the most important improvement made to existing techniques is the general use of hot closing of containers and their rapid cooling after processing.

Depending on the product, hot closing is obtained either by the addition of hot brine, by heating the product before it is filled or by the general adoption of heat exhausting before closing.

The re-heating of pasty materials is carried out in standard equipment consisting of a steam jacketed tube through which the product is carried by a screw which is sometimes also heated.

As regards exhausting, it is mostly done with hot water, preferably heated by steam, and the exhausters used are of various types, differing only in the methods of carrying the containers through them. The most recent model (Type P.C. Licence P. CARVALLO) is fitted with a conveying chain of special construction, which allows of automatic linking of the filler to the seamer, as well as of conveying different shapes of cans. They are also equipped with controls maintaining a standard water level and for the re-use of the hot water.

The principle advantages are uniformity of treatment of the cans and a notable saving in steam consumption by the re-use of the hot water from the overflow.

In addition, for several years, equipment for closing cans or glass jars under steam jets, has been used.

The rapid cooling of containers after sterilisation is carried out by immersion in cold water either at atmospheric pressure after coming out of the retort or under pressure in the retort itself.

In the field of general equipment, the most notable progress has taken place in equipment for filling, seaming and sterilising and in the equipment generally called "end of line". In fact, all equipment for packing in cans or glass jars, has been improved. Models based on new principles have been made and the use of automatic fillers has spread to all products for which they are suitable. It is the same for high speed seamers, of which several French manufacturers have produced improved models for round as well as for irregular cans (1).

NOTA. Figures between ( ) refer to Bibliography, p. XV - 6

As far as sterilisation is concerned although the vertical retort using steam or water has remained until now the most usual equipment in France, it has all the time been improved in detail to give, on the one hand, better control of the sterilisation operation, e.g. the mercury thermometer and the recording thermometer, and on the other more rational operation, e.g. automatic control of pressure and temperature and equipment for pressure cooling in the retort itself. A certain number of canning lines have been equipped with continuous pressure cooker coolers, a new type of particular interest being the P.C. 100-102 (2).

This has recently been built by a French manufacturer and is of entirely new design, and one more rational than all other continuous pressure cookers now existing.

It consists essentially of three vertical columns each about 10 m high in which is carried out pre-heating, sterilisation and cooling respectively. In the pre-heating and cooling columns, which are open to the atmosphere, there circulate respectively, currents of hot and cold water. The sterilising column contains steam under pressure. The loading and unloading of the cans takes place either at the top (P.C. 102) or some other level of the equipment, either at the bottom (P.C. 100) or half way up (P.C. 101), according to the particular requirement of each factory.

The cans are conveyed through the cooker in tubular perforated baskets which are attached at their ends to an endless chain of new design, which carries them successively through the three columns for pre-heating, sterilising and cooling.

The loading and unloading of the baskets is carried out automatically by a synchronised pusher arm which takes the unsterilised cans from a conveyor coming from the seamers and places the cans coming from the steriliser on a belt which carries them to the labelling and casing machines.

The advantages of these sterilisers are particularly :

- the use of tubular baskets which enables all shapes of cans with a maximum dimension less than the diameter of the baskets and even glass jars to be handled and ensures the independence of the conveying mechanism from the containers and of the containers from the conveying mechanism;

- the use of columns of water which allow of the introduction of the containers into and removal from the sterilising chamber without any special valve mechanism. These pre-heating and cooling columns form hydraulic joints and keep the steam inside the sterilising column. Besides the simplicity and security resulting from the elimination of all valves, this principle allows of a gradual increase in the pressure on the cans as their temperature rises and a progressive diminution of the pressure as they become cooler. It also avoids the introduction of air into the sterilising chamber with the cans and hence gives better heat conductivity from the steam and greater uniformity of the conditions of heating;

- the use of counter current working which allows of the progressive heating and cooling of the container and thus involves less strain upon metal cans and opens up the possibility of handling glass containers, and the re-use of the heat from the cooling water.

The equipment works at a normal sterilising temperature of 120°C and under this condition its output is of the order of 150-1/1 cans (850 ml each) per minute.

The sterilising temperature may be adjusted at will by simply raising or lowering the water level in the columns, by varying the height of the overflow in the cooling compartment. In fact, it is the height of the water which acts as controller of the steam pressure in the sterilising column, and the uniformity of this level and hence of the pressure and temperature of the steam during operation, is maintained by a simple regulator of the "Genevet" type or a similar system with an accuracy of $\pm$ 2 centimeters, that is about 1/25°C.

Finally, certain ancillary equipment for loading and unloading batch retorts and for the mechanisation of the handling of filled cans by the use of labelling machines, casing machines, etc., has been developed to such an extent that a certain number of canneries are able to handle filled cans completely automatically from cooling to warehousing.

In addition to the various improvements mentioned above, and in connection with the efforts made by factories to improve their organisation and the rationalisation of production, should be noted the increased use of mechanical methods for handling raw materials and empty containers, e.g. the perfecting and adapting of various means for conveying material in course of manufacture from one point to another in the factory or for joining different items of equipment : conveyor belts of various types and kinds, bucket elevators hydraulic methods of conveying using pumps and flumes, cable and slat conveyors for filled and empty cans etc...

Finally the effort made towards improving hygienic conditions of manufacture has resulted in particular, in the greater use of stainless metals, chiefly stainless steel, in the choice of equipment which is easily cleaned and in certain cases by the use of modern antiseptics and detergents for cleaning and sterilising it. Chlorinated water is also used for certain purposes such as the cooling of cans.

Having thus reviewed the improvements made in methods and equipment common to the different types of canned food it now remains to examine the modifications and developments specific to each one of them.

I. CANNED FRUITS AND VEGETABLES

As regards vegetables, it is in the manufacture of canned peas, green beans and tomatoes, which are the main products, that the greatest progress has been made.

Firstly, for these three products great efforts have been and are being made to improve the quality of the raw materials, by the selection and production of new high yielding varieties, which are well adapted to the treatment they will receive during canning, e.g. peas especially adapted to vining and giving a high proportion of "fines", green in colour, sweet and tender and with as little starch as possible. Green beans without strings and skin allowing of mechanical snibbing. Tomatoes of high total solids with deep colour and resistant to disease.

In the pea canning industry manufacture has been highly mechanised and made entirely continuous by the installation of complete canning lines.

The harvesting of peas by mowing and vining the whole plant has become more general and is more and more replacing the hand picking of pods. The viners used are generally more or less replicas of American models adapted to the special conditions of the French canning industry.

In graders no marked improvement has been made other than certain modifications in detail to increase their efficiency and output.

Cleaning equipment and in particular washers and stone removers, have been improved but without modification of the standard principles used for some time past.

A few factories have used brine graders of American origin and the hydraulic conveying of peas from one piece of equipment to another has developed, thanks to the production of pumps specially built for this purpose.

The canning of green beans also tends to be more mechanised, largely because of the development of varieties without skin and strings and by the adoption of equipment for sorting, grading and snibbing as used in the United States.

For tomatoes the major developments are concerned with the improvement of equipment for sorting and washing which result in a reduction in the infection of the raw material.

The mechanisation of tomato canning has also been increased by the use of Italian made lines consisting of hot breakers, de-seeders, pulping machines, heat exchanges and finishers. On the other hand, great progress has been made in the field of concentration where the Italian "boules" have been replaced by concentrators with rotating heating elements, sometimes with multiple effect evaporation, which allow of the concentration of the puree at a much lower temperature than in the past, from which results a marked improvement in the colour and flavour as well as an increase in the content of thermolabile nutrients.

Finally, the filling of tomato concentrates at a temperature of about 90°C has become general, which eliminates the need for sterilising the filled cans, at least for the larger sizes.

In the canning of fruits, mechanisation is less developed than in canned vegetables because of the greater variety of raw materials which are handled.

However, mechanical graders using divergent belts have been adopted for the size grading of certain fruits such as cherries and plums, which are stemmed and pitted by machines which differ only in detail from those used in all other countries. The mechanical pitting of fruit such as apricots has been the subject of some investigation and certain patents have been taken out, but the machines are not yet in commercial use. The general use of lye peeling for peaches should be noted.

Finally, sterilisation is now more and more carried out in cooker coolers at atmospheric pressure, in which the cans are rotated about their axes. Several types of such equipment, based on different principles, have been made in France, those most used having been developed by P. CARVALLO of which there exist several models. They usually consist of two rectangular containers joined together, with a constant level of water, one being heated by steam coils and acting as a steriliser and the other fitted with counter current of cold water for cooling. In each container the cans are placed horizontally and moved forward by rotation on a track over which they are dragged by a system of chains and slats. The speed of movement and rotation is adjusted by a variable speed gear on the driving chains.

Amongst the other systems of continuous cooking and cooling at atmospheric pressure developed during the last few years, the "Hema", Ribes and Pallu systems should be noted.

In the first two the heat treatment is carried out while the cans are rotating, while in the latter the cans move forward in a vertical position without rotation.

<u>In the "Hema" steriliser</u> (3) a cylindrical rotating drum carries the cans along a continuous helical track which moves them forward and rotates them.

<u>The Ribes cooker cooler</u> (4) consists of two containers, one on top of the other, in the form of a horizontal ring, in the inside of which two helical tracks are placed. These are coaxial and of contrary thread joined together at their lower ends. Movement of the cans is produced by means of a system of vertical pushing bars which carry them forward at all levels of the spiral track. The machine has no mechanical parts turning in the water, the rods moving the vertical pusher arms being driven by a motor placed in the free-central space of the containers.

<u>The Pallu</u> (5) equipment has a conveyor system of "balancelles" which carries the cans continuously in a vertical position through the sterilisation and cooling baths after having passed through a pre-heating section. It has been more specially designed for handling glass jars.

Finally, there should be noted a system of cooking and cooling in a water bath under agitation, known under the name of "paniers-rotors" (6). In this system the cans are arranged in a cylindrical perforated drum of special design which can turn in a vertical plane inside a trough of rectangular section with a semi-circular bottom. The rotation of the basket is carried out by the action of small steam jets playing on paddles mounted on the periphery of the basket.

I. CANNED MEATS

In this branch few inovations can be found except the increased use of refrigeration and of air conditioning in meat preparation rooms. The use for pasty products of a vacuum "Jaeger" (7) mixer consisting of a spherical container with an air tight lid which revolves about a horizontal axis which at the same time drives the mixing arms in the opposite direction to that of the container. After loading and closing the lid the apparatus is connected to a vacuum pump and when sufficient air has been withdrawn it is rotated. The particular use of this method lies in the high degree of deaeration of the product mixed and the elimination of sharp angles in the equipment which reduces the risk of heating and crushing the particles of meat.

Amongst other developments in the meat canning industry is a tendency towards the use of vacuum closing of cans for various products.

III. CANNED FISH

The tendency towards mechanisation and the use of automatic equipment which has characterised the food canning industry in France in the last decade has only really touched the fish canning industry since 1946/47. Until this date developments in the industry have been mainly concerned with the organisation and rationalisation of work in the factories by a modification of methods or of equipment. It is in this sense that one should note :

- the use of mechanical arrangements for conveying the fish and the cans to the operators who are beheading, traying or packing sardines. This equipment of the "roundabout" or continuous belt type permits in particular a great reduction in "goings and comings" and in loss of time by the operators;
- the use in sardine canning lines of mechanical briners and washers (8);
- the introduction of semi automatic equipment for the beheading, boning and packing of tunny (11).

Apart from these improvements the standard methods of manufacture had not changed very much.

However in the last few years several entirely different methods of preparation have been perfected which give a much higher degree of mechanisation in manufacture.

At the present time there exist apart from the standard methods of frying in oil (for sardines) and of cooking in brine (for tunny and mackerel) two general methods for cooking and drying applied specially to sardines, and distinguished by the fact that in one heat treatment is carried out before packing in the cans, whereas in the other it takes place after the fish are in the cans.

I. Cooking before canning

a) Cooking in hot air or steam

The method consists essentially of the replacing of the standard frying by treatment in hot air or steam by conveying the fish through tunnels or by holding them in ovens.

Cooking in steam before packing has not been adapted to any continuous equipment, but various continuous systems for cooking in hot air have been suggested during the last few years. Among these the Toquer system seems of most interest.

This system consists of a whole range of technical innovations compared with the usual procedure. Its essential characteristic is the continuous and automatic organisation of all the treatments to which the fish is subjected, between evisceration and the final treatment, before packing in cans. It is designed in principal for handling small fish (sardines or sprats) but with certain modifications may be used for the semi-continuous preparation of other fish such as mackerel, tunny, etc...

The Toquer sardine line (10, 11) consists of a large horizontal tunnel in steel in which are carried out the cooking and drying in hot air, and at the entrance of which is placed a mechanical arrangement for preparing the fish. At the exit of the tunnel is a special system of tables for trimming and hand packing, consisting of a continuous woven wire belt. At the beginning of the tunnel the whole fish, previously brined are hooked by hand by their tails to flexible clips fitted on specially designed frames. As these frames are filled they are clipped on to a conveyor chain which carries them successively :

a) through a mechanical beheading evisceration station;

b) through a water jet washer;

c) the cooking drying tunnel followed by an air cooling section.

On leaving the tunnel the frames come on to the packing tables where mechanical trimming of the neck takes place and finally the fish are unhooked and packed by hand in the cans by standard methods. The line is capable of handling 500 kilogrammes of sardines per hour.

For tunny and other fish the raw fish, trimmed and cleaned is placed in moulds without bottoms of a shape similar to the final containers. The filled moulds are carried on cooking trays through the oven. On leaving the oven the packing of the cooked fish is done simply by placing the contents of the moulds in the cans. This line is capable of handling about 800 kilogrammes of fish per hour.

b) Infra-red cooking

A variation of the method of cooking by hot air is that of cooking by means of infra-red radiation produced either electrically or by gas. We will not consider here the methods of treating the fish by electrically produced infra-red radiation which in spite of preliminary encouraging results has not been developed commercially in France. It is worth while, however, to mention the first infra-red cooking tunnels heated by gas were used on the Biscayan coast in 1949/50 (13, 14). These ovens consists of tunnels fitted with conveyors the fish being placed on trays or similar containers and carried through the tunnel in which they are cooked and dried not only by the high temperature of the surrounding air but also by the infra-red rays produced from tubular emitters and concentrated on the fish by reflectors placed along the internal surface of the tunnel. The main interest in infra-red radiation lies in its power of penetrating some distance into the fish thus, giving a uniform cooking and a rapid drying from the interior of the tissues.

2. Cooking in the cans

The mechanisation of continuous methods of manufacture made a great step forward with the development in France of systems for cooking the fish after packing in the can. The research work undertaken in France after the war has resulted in the perfecting of two general methods of treatment of sardines and other small fish.

a) The M. & P. system (Mather & Platt),

b) The I.M.C. system (International Machinery Corporation).

The two systems have several similarities in principal but they differ widely in the practical details of construction and design. In the first case it should be noted that the M. & P. line is really only semi-automatic whereas the I.M.C. line is designed for continuous and automatic operation from the packing of the fish in the cans until seaming.

The M. & P. line (11) consists essentially of a grouping of three tunnels similar to steam exhaust boxes with conveyor belts. The first two tunnels are joined together directly whereas the second and third have a centrifugal drier between them. The fish, brined, beheaded and degutted following the usual methods are first of all packed raw in the cans which are then placed in single file on the conveyor which carries them through the first two tunnels. In the first tunnel (the pre-cooker) they are subjected to hot air, in the second (the cooker) to steam. On leaving the cooker the cans are placed by hand on metal trays with wire mesh covers. These trays are then placed vertically in a centrifugal drier running at a speed of about 450 revolutions per minute. This draining operation has the object of removing the liquid phase (juice and fat) exuded from the fish during cooking. After drying the trays are taken from the centrifuge and the cans are unloaded. They are then placed on the belt of the third tunnel (the drier) where they are subjected to a current of hot air to complete the drying of the fish. Oiling, seaming, sterilisation and cooling follow and are carried out by standard means. The capacity of the M. & P. line is of the order of 3,000 1/4 club cans per hour or approximately 700 kilogrammes of raw fish per hour.

The I.M.C. line (15) consists of a single mechanical unit comprising three essential sections arranged in the form of superimposed tunnels, first a steam pre-heater, then a hot air cooker, and then a steam exhauster. The three sections are joined together by a conveyor belt which carries the cans continuously from one to the other. The raw fish is prepared and then packed by hand in the cans previously sprayed with oil and filled with a pre-determined quantity of brine. The filled cans are then placed on a loading platform at the beginning of the machine where they are grouped in lines of a variable number of cans according to their shape and the size of the machines. These lines of cans are then covered with a wire mesh tray, so designed as to attach each line to the transporter chain of the machine. After they have been thus attached, each line of cans is carried successively through the three sections of the equipment. Before going into the first section the cans are inverted to drain off the original brine and eliminate all traces of blood, scales, etc.. They are then returned to a horizontal position and passed under a series of jets where each can automatically receives a fixed quantity of fresh brine. They then go through a steam tunnel where they receive a preliminary cooking in brine. On leaving, they are turned upside down, which allows the brine to drain away and in this position, they enter the hot air cooking and drying section, made up of a number of superimposed horizontal chambers. Attached to the conveyor chain the lines of cans pass through these chambers alternatively right way up and reversed in such a way as to permit the draining of the fat and juice exuded from the fish during the cooking. The cans then enter the exhaust section at the entrance of which a series of jets automatically put into each can a pre-determined quantity of oil. On coming out of the machine the wire mesh covers are automatically unhooked from the conveyor chains which continue through a degreasing section under steam jets before returning to the loading station. The cans are then carried to a seamer and so to the sterilizer.

The I.M.C. machine is now made in three models which differ only in their output. Model 330 for 50 1/4 club cans per minute (with covers for conveying the cans in lines of eleven), the 230 model, 25 1/4 club cans per minute (cans in lines of eleven), and the 430 model, 200 1/4 club cans per minute (with covers for 34 cans arranged in two lines).

In the latest models the exhausting section has been eliminated since the high temperature at which the cans come from the ovens is sufficient for closing hot, particularly as the oil added to them from the jets is kept as a temperature of 90/100°C.

In order to complete the continuous mechanisation of the preparation lines, efforts have recently been applied to perfecting machines for the automatic beheading and evisceration of sardines. The beheaders designed up to now have never given complete satisfaction commercially since the problem of mechanical beheading was complicated by the absence of suitable automatic equipment for size grading and placing of the fish in the beheading machine. Recent investigations seem to have given more promising results, and in the near future, commercial tests on a high output line will be carried out. The line will consist of :

- a roller grading machine for separating the sardines into three sizes;
- a machine to place the fish and feed them to the beheading machine;
- a mechanical beheading machine adjusted to handle fish of each size grade.

(The capacity of each beheading machine will be in the order of 100/120 fishes per minute). This equipment will be followed by hand packing tables and an I.M.C. cooker.

Along side these improvements should be noted the research work carried out on cleaning and recovering frying oils, a method based on the differing emulsifying power of vegetable and fish oil has been suggested (9) but as yet, has not been develcped on a commercial scale.

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XVI. THE CITRUS PRODUCTS INDUSTRIES OF ISRAEL

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Although citrus fruits were grown in Palestine for nearly two thousand years for local consumption, stimulus for this production began with the instant popularity which greeted the exports of the Jaffa or shamouti oranges when they first were exported to England in the middle of the nineteenth century. The expansion of the area planted with oranges and other citrus fruit occured largely during the twenty year period between the two world wars owing mainly to the influence of Jewish settlers and Jewish capital. It was as a result of this expansion, particularly during the 1920s, that attention was given to the development of a citrus products industry. The disposal of the large annual quantities of culls (fruit not suitable for export) and of surplus fruit began to be important. The utilisation of unsalable fruit for local markets began with the production of sulfited juices and essential oils in a small factory at Ramat-Gan, near Tel-Aviv, in 1928, and was followed in 1932 by the establishment of a factory in Rehovot for the production of citrus juice beverages from sulfite preserved juices, essential oils and dried peel for cattle fodder. A few years later there was established at Rehovot the first plant for the production of vacuum concentrated citrus juices for beverage use. The second world war led to the rapid expansion in the manufacture of citrus products, and particularly to the production of citrus juice concentrates for export to England as a source of vit.C. The requirements for marmalade, juice and canned grapefruit by the Allied Armies in the Middle East during the war also contributed to the expansion of the citrus products industry.

The citrus fruits grown in Israel commercially at present are in order of importance :

1) the oval shaped, seedless, sweet Jaffa orange - locally known as shamouti - characterized by extremely tender locular walls and rather thick easily removable peel. Its superior quality for eating out of hand has made it popular in the United Kingdom, which receives over 60 % of the fruit exported and also in Holland, Belgium, Sweden, Poland, Norway and France which with England were the chief importing countries. The shamouti is normally harvested from November to the middle of April;

2) the Marsh seedless grapefruit which is harvested from October to late April;

3) the late Valencia orange, usually harvested from the middle of March to end of April;

4) several varieties of lemons;

5) mandarines, clementines and Sevilla oranges, locally known as hushhash.

Table I, page 2, gives a survey on area planted with and utilization of these different citrus fruit comparing the 1938/39 season where production was at its height with conditions as they prevailed this last season 1950/51.

During the past three years the citrus fruit crop was utilized for export as fresh fruit, for distribution as fresh fruit for local consumption, for processing into citrus products for export and for processing into citrus products for local consumption.

Table II, page 2, shows the utilization of the total citrus crop in the seasons 1948/49, 1949/50 and 1950/51.

TABLE I

PLANTED AREA AND UTILIZATION OF VARIOUS FRUITS IN 1938/39 and 1950/51

Variety	Area in dunams(1)	Tons fresh fruit exported	Local market tons fresh fruit	Tons processed
Shamouti & Valencia				
1938/39	242,500	522,230	-	-
1950/51	93,190	147,500	43,496	85,327
Grapefruit				
1938/39	37,500	70,000	-	-
1950/51	10,500	25,850	6,393	14,063
Lemons				
1938/39	5,000	4,300	-	-
1950/51	3,153	480	3,710	2,659
Other Citrus				
1938/39	14,500			
1950/51	5,102	-	15	-

(1) 1 dunam = 1.000 m^2.

TABLE II

UTILIZATION OF CITRUS CROP IN THE LAST THREE YEARS

Year	Dunams planted (1 dunam = 1.000 m^2)	Tons consumed as fresh fruit	Tons fresh fruit exported
1948/49	-	15,504	161,809
1949/50	-	22,736	74,000
1950/51	126,795	55,599	173,830

TABLE III

EXPORTS OF THE CITRUS CONCENTRATES PRODUCERS ASSOCIATION TILL JUNE 1951 (TONS)

	1948/49	1949/50	1950/51
Sulfited orange concentrate 6:1 in barrels	1 475,085	681,872	673,253
" " " 4:1 " "	45,672	--	--
Sterile orange concentrate 65°Brix in No.10 tins	1 876,704	1.121,469	2 926,166
" " " 5:1 in No. 10 tins	44,549	11,772	--
" " " 6:1 " " " "	--	23,499	31,836
Sulfited grapefruit concentrate 4:1 in barrels	60,411	136,678	137,771
" " " 6:1 " "	83,012	47,765	37,912
" " " 7:1 " "	39,713	57,005	42,858
Orange pasteurized juice in No. 2 tins	5,811	56,867	125,000
Sulfited orange cells in barrels	396,954	214,604	126,453
Sulfited grapefruit cells in barrels	0,521	9,272	--
Sterile orange cells in No. 10 tins	2,349	2,616	--
Sulfited sweet orange pulp in barrels	31,[illegible]84	12,034	25,367
Bitter orange pulp in barrels	70,041	--	25,184
Sulfited grapefruit pulp in barrels	7,892	--	5,205
Sterile orange pulp in No. 10 tins	--	--	15,512
Peels in brine	146,454	103,970	67,870
Orange slices in sirup in No. 2 tins	--	--	1 263,046
Orange segments in sirup in No. 2 tins	--	--	430,710
Orange oil	51,501	55,768	45,985
Grapefruit oil	2,919	2,524	1,115
Lemon oil	3,965	1,268	--

Table III, on the preceding page, gives a survey of exported citrus products in the last three years. Because the need for a more orderly production and marketing of citrus fruit was evident for a number of years before the second world war, the Palestine Citrus Control Board was established in 1940. This had control over the existing and projected citrus growing areas and over the picking, packing and handling of citrus up to and including shipment. The Citrus Marketing Board was set up for controlling and regulating the marketing of citrus fruit grown in Palestine. When the State of Israel was proclaimed in 1948 these functions were vested in the new Citrus Control and Marketing Board. At this time about 47 % of the citrus growing area of 232,000 dunams was Jewish owned. Early in 1949 the citrus growing area of the State of Israel suffered a marked reduction in size and of the total citrus area of 121,000 dunams 80 % was Jewish owned. The adandoned Arab owned orchards were largely neglected and lack of irrigation, cultivation and the severe winter of 1948/49 caused widespread and severe damage. The productivity of the Jewish owned Citrus orchards was reduced by restricted availability of organic fertilizer, irrigation and cultivation which resulted not only in reduced yields but also in poor quality. Steps are now being taken to improve existing orchards, reclaim those of the abandoned orchards which can be and to expand production by new planting. Improvement in quality and yield through a better balanced fertilization and an investigation of the suitability of different rootstocks are also necessary. Until now the rootstocks used for Grapefruit and Valencia are mainly from bitter orange. For shamouti in light soils sweet lemon is used. The citrus fruit is grown in small and large privately and cooperatively owned orchards ranging in size from 10 dunams to over 200 dunams. Cooperatively managed small orchards include those owned by the communal agricultural settlements, the kibbutzim, and those owned by private agricultural settlements, the moshavim. The fruit is packed and shipped by trucks to both private and cooperatively owned packing houses ranging in size from 900 m^2 for 100,000 boxes packed annually to 1600 m^2 for 400,000 boxes packed annually. These packing houses vary from small and primitively equipped ones in which the fruit is merely brushed and wrapped by hand in dipehenyl impregnated paper to large units where the fruit is washed, sterilized in borax solution, size graded and waxed before wrapping and casing. The wooden boxes used are secured by wood strips. The size of these boxes is 74 x 37 x 30 cm containing 120, 150, 180, 210, 240, 294, 336 and 360 fruits according to sizing. Owing to scarcity of materials and equipment packing is not as standardized or as well mechanized as it is e.g. in the United States. The oval size of the Jaffa fruit and its tender peel also present problems in handling, necessitating modification in existing citrus packing machinery. Since the fruit is not precooled at the packing sheds and may be held several days without refrigeration it is now inspected at the shipping point and Decca fumigated with NCl_3 and HCN before shipment. Even under these conditions spoilage in shipment on unrefrigerated boats to England has been held to a minimum, usually not over 5 %. Rigid inspection at the shipping port, Decca fumigation combined with the surprisingly high resistance to infection of the Jaffa orange have been responsible for this relatively low incidence of rot and decay.

The Citrus products industry in Israel is also highly organised and controlled through the Citrus Concentrates Producers Association which was established in 1944. This trade association is composed of 13 member firms ranging in size from plants expressing 60 to plants expressing 300 tons of fruit in 24 hours which cooperate with each other in improving the efficiency of production of citrus concentrates and other citrus products, in establishing uniform standards of quality and identity and in enforcing these standards for the export products. To promote the welfare of the industry, to develop production methods and controls and to assist the industry in solving its current production problems and to develop new products and operating methods the Central Research Laboratory of the Citrus Concentrates Producers Association was established in 1947 through the far-sighted vision of J.B.S. BRAVERMAN who also was its first director. This laboratory now has a staff of 5 graduates and 5 assistants and is also supported by the Scientific Research Council of Israel. It has carried out research on chemical, bacteriological and technological problems. The Citrus Concentrates Producers Association through its field department arranges for the procurement of cull fruit in the packing houses and of packed fruit rejected at the harbors as unsuitable for shipment abroad and its allocation to member plants for processing. Arrangements are made for the transport of this fruit in bulk loaded trucks of from 1 to 15 tons capacity on an equitable basis to all plants, so as to avoid overloading the capacity of an individual plant and to keep all plants operating to as nearly their capacity as possible. It also assists the member plants in obtaining the cans, cases, labels, and other materials and serves them in their relations with the various agencies of the Israeli Government on general issues. It also arranges for shipment of the products abroad. The Citrus Concentrates Producers Association has been expanded to include vegetable canning as well as citrus products since the citrus concentrate producers utilize their facilities for the processing of cucumbers, tomatoes, and a variety of vegetables, as well as for jam and preserve production. Although at present the industry is largely based on the utilization of surplus agricultural crops during the peak of seasonal production, steps are being taken to place it on a more sound basis through the development of crops grown for processing. The present economic conditions largely due to the unprecedented rate of immigration and the need to absorb and settle the newcomers have caused shortages in raw material and services which have handicapped the development of the fruit and vegetable processing industries.

The citrus products industries have developed and are being developed under difficult conditions, but by interesting adaptation of equipment and processes developed abroad, by improvisation and by ingenious local development are now on a fairly stable basis. As an illustration of the manner in which a particular market in England and local consumption requirements have combined to promote the establishment of an industry under difficult economic conditions (restriction in allocation of currency for purchase of equipment, scarcity and high cost of untrained labor as well as trained labor, shortage in structural and building materials, shortage in cans, cases, adhesives, equipment, power and even water, an unfulfilled local demand creating a sellers market) there are many useful lessons to be learned from the present situation in Israel.

The citrus products now being produced in Israel in order of their importance are :

1) canned concentrated orange juice for export. The concentrate made chiefly from Jaffa oranges is produced for the British Child and Maternal Welfare Feeding Program and must meet the minimum standards for degree of concentration, yeast and bacterial count, vitamin C level and fluidity. Since it is transferred from cans into bottles for distribution and must be fluid enough to be readily diluted and used in child feeding, fluidity of the concentrate is second of importance to high vitamin C content and freedom from microbial infection. This concentrate is packed in No.10 cans to meet the following specifications : 65° Brix uncorrected for citric acid, 220 mg vitamin C per 100 g, no viable yeasts, now viscosity measured with the Ingram pipette;

2) barrelled sulfited citrus juice concentrate for export and for the local beverage industry including :

a) orange concentrate, usually concentrated 1:6;

b) grapefruit concentrate, usually concentrated 1:4 and to a lesser extend 1:6 and

c) lemon concentrate, concentrated 1:4.

All these concentrates are preserved with 1500 ppm SO_2.

3) Bulk stored sulfited citrus juices for beverage use usually preserved with 1000 ppm SO_2;

4) Canned orange slices and segments in sirup;

5) Citrus fruit pulp and cells for beverage use;

6) Citrus fruit pulp for jams and marmalade making;

7) Citrus peels in brine for export and local candied peel manufacture.

The citrus by-products from the peel are :

1. dried stock feed from peel;
2. essential oils;
3. alcohol from peel juice;
4. alcohol from ground whole peel.

The present practices used in the production of these citrus products are discussed in general rather than in particular aspects since they vary from plant to plant because of differences in available processing equipment and processing methods and facilities.

I. CANNED ORANGE JUICE CONCENTRATE

1. Fruit handling practices

The fruit is hauled to the plants in bulk in trucks varying in size. As abroad this practice because of the damage to fruit at the bottom layer by that above results in contamination of the juice but since the attention here is largely focussed on osmophilic yeast contamination this is not so serious. The experience in Israel is that the surface of the fruit is not an important source of contamination of the concentrate with yeast, particularly with osmophilic yeast. It has been found also that the fruit surface early in the season is particularly sterile whereas later in the second season it becomes more heavily contaminated. This is reflected also in the fact that the juice expressed early in the season is more sterile and much more resistant to yeast infection than later in the season. This behaviour has been correlated with the occurence of a natural growth inhibitor in the peel oil and investigations on its properties and distribution are now in progress. In addition to danger of microbial contamination, bulk handling of the fruit particularly during the higher prevailing temperature during the latter part of the season in Israel does damage quality. How this practice affects the stability of the vitamin C and the activity of pectic enzymes, particularly as they are related to changes in fluidity of concentrate is not known. The fruit after weighing at the factory are dumped from the trucks into recovery bins. Since dump trucks are not available in Israel various methods of dumping have been improvised. In the simpler the truck is backed down and incline until it rests on two concrete blocks and then the back boards are removed and the fruit is dumped. In more widely used methods the truck is backed to the unloading bin and its front wheels are raised by a hydraulic ram. In both cases the fruit falls at first about three to four feet and is bruised and also hand labour is required to complete unloading. The fruit is then lifted by several types of bucket elevators to the top of storage bins. A variety of storage bins - usually concrete construction - are used and some attempt is made by the use of divided feeders to reduce damage during filling and during storage. The fruit is fed from the bottom of the bins through trap doors into some type of a conveyor. The bottom of the bin is constructed at an inclined grade to facilitate unloading of bins but the bin design does not usually lend itself to continuous discharge but necessitates additional scraping out by improvised rakes. The fruit from the external bins is fed by a conveyor (slatted type drag conveyor, water flume, water flume with helical screw, water flume with rotating paddles) past rotating brushes and spray washers into the extraction units. The washing of the fruits from the bins is not always satisfactory and since sorting facilities prior to bin storage or from bins to washers are not provided the fruit entering the extraction unit is not clean enough. Since all factories are closed from Friday evening until Saturday evening or Sunday morning for the Sabbath, this presents additional problems. Usually the fruit at the start of the week is not used for the production of canned concentrate for export but for sulfited concentrate or juice so as not to impair the quality of the latter. Although some aspects of the effect of fruit handling practices on the quality on citrus juice and concentrate have been investigated, much more must be done in this field. More attention particularly has to be given to the design and operation of the washers so that the maximum washing of the fruit with the minimum use of water can be accomplished. Sorting of the fruit prior to bin storage and washing to reduce the contamination load and better design of washing facilities (soaking, spray design, distribution of sprays) are necessary. Fresh water is used for spray washing and in some cases reused in flume conveyors which serve also as soakers. Although at present germicides (hypochlorite or quaternary ammonium compounds) and detergents for washing are not available, they are desirable particularly since the fruit as received is not washed or sterilized at the packing plants prior to diversion to processing plants.

2. Juice extraction

The juice is automatically extracted in either the Food Machinery Corp. juice extractors (in two of the plant) or in locally designed or built rotary presses. In the former case the fruit after washing is

graded into three size grades in roll graders specially developed for the oval shaped Jaffa fruit which cannot be size graded in the usual Valencia orange sizers. As it is conveyed to the sizers the fruit is given a preliminary inspection to remove rotted or badly damaged fruit, but facilities for careful sorting are not available or used. After rough size grading the fruit is fed into F.M.C. extractors where the juice is expressed and separated from the peel-oil and juice and whole peel in the usual manner.

Most of the fruit is expressed in the Koffler rotary presses after preliminary grating in Koffler graters to gain the peel oil. In the Koffler grater the fruit has to move slightly upward under sprays of water by rolling and jumping over 20 rollers which revolve all in the same direction. They are made from stainless steel into which holes are pinched in such a way that the sharp edges are on the outside. A grater handling 8 tons of fruit per hour has a grating surface of 10 m^2. The grated fruit is then size graded and fed into rotary presses for extraction.

The chief modification of the usual rotary press such as still used in Florida lies in the development of a pressure head with separate outlets for the bulk of the more readily expressed juice from the centre portion of the halved fruit and from that expressed towards the end of the operation at higher pressures from the outer portion of the pulp and of the peel. The yield of the first juice which is of much higher quality is about 90 % of the total. As used for concentrate production both streams of juice are combined.

The relatively thick soft juice peel of the Jaffa orange presents difficulties in extraction from the F.M.C. machines because if the clearance is adjusted to give good yields the expressed juice becomes too thick for the required viscosity limits. If the setting is such as to obtain the desired fluidity then the yield is lowered. With the Koffler rotary press less of the viscous peel juice is obtained and the yield is higher. Furthermore because of the oval shape of the fruit modifications have to be made in conveying the fruit to the extractors. It is often necessary to station personnel at the F.M.C. extractors to maintain a uniform feed and prevent clogging of the machine. The oval shape of the fruit presents also additional difficulties in the setting of the clearance of the F.M.C. extractor. The juice yield obtained by the Koffler machine is better than 40 % of the weight of the fruit for oranges and grapefruit and one third of the weight of the fruit for lemons. Yield from the F.M.C. extractor is usually about 10 % less than from the Koffler machine. The Koffler machine expresses from 4 to 5 tons of fruit per hour whereas the F.M.C. expresses over 5 tons. For both machines the amount of fruit expressed per time unit depends of course on the size of the fruit and the efficiency of the sizing operation.

3. Straining

The extracted juice is strained in order to remove coarse pulp particles which would affect not only the appearance but also the fluidity of the concentrate. This straining is accomplished usually by the use of two rotary perforated screens, having perforations of 2,5 to 3,0 mm in the first and 0,7 to 0,8 mm in the second screen. The pulp of the Jaffa orange is so tender that the helical screw strainers used in many overseas plants are not satisfactory because they express so much pectinous liquid into the juice as to give trouble from pectin-sugar-acid gel formation in the concentrate. The type of strainers and the sequence of straining operations varies from plant to plant, depending on type of extractors used, and availability of equipment. The F.M.C. extracted juice has to be strained more carefully and thoroughly than the Koffler extracted juice. The pieces of peel and coarse pulp from the F.M.C. extractor after initial separation on rotary screens are then further pressed in a rotary helical screw expeller press to yield a thick juice which is used in the production of sulfited juice. The finer pulp separated from the second screen is used for the production of preserved pulp or cells for beverage use. It is usually pasteurized to prevent formation of Ca-pectate jellies through pectinesterase action and preserved with SO_2. In spite of sufficient addition of sulfite fermentations still occuring present a problem.

The fluidity (so-called viscosity) of the concentrate apparently is influenced to a large extent by the amount of juice sacs held in suspension and by the size of the pulp particles. The quantity of pectic substances present in the strained juice and their distribution into pectin and pectinic acids of different degree of polymerization also influences the fluidity.

Although preliminary investigations have been made of the rheological properties of the juice and concentrate much more remains to be done to determine the effect of suspended coarse particles, of colloids and of soluble solids on the flow properties and consistency of juice and concentrate. Fundamental research in this field has not been carried out either in Israel or elsewhere.

4. Heat treatment

The strain juice is pasteurized in APV plate pasteurizer at temperatures and holding times varying from plant to plant from 88°C and 25 sec. to 95°C and 20 sec. holding time and from there pumped to vacuum concentrators. The juice is usually deaerated prior to pasteurization by passage through deaerators of the spray injector type but whether this deaeration performs any useful purpose in production of concentrate is not known. The heat treatment is used for the purpose of inactivating pectic enzymes but there is no available information on the thermic sensitivity of the pectic enzymes in the locally available fruit. Investigations are not being made on the activity and distribution of pectic enzymes to better determine the conditions of temperature and time of heating necessary to inactivate the pectinesterase.

5. Concentration

The heated juice is pumped directly into locally built and designed single effect gravity flow vacuum pans. These were designed by KOFFLER to obtain high ratio of heat transfer and high evaporative capacity with minimum heat injury to the juice. The evaporator is constructed of stainless steel with all

parts easily accessible for cleaning through hinged doors. It is equipped with a barometric condenser and is also provided with a stainless steel pump for forced circulation of highly viscous liquids. The vacuum is created by pumps of which all types, locally made or brought from abroad, can be encountered in different plants and is rarely below 730 mm. The temperature at which the juice is concentrated varies from 36°C in the initial stages to 45°C at later stages of concentration. Under these conditions some heat damage does occur but the extent of this heat damage and the effect of conditions of concentration upon this is not known. The heat damage results in the production of sugar degradation products which contribute to browning and also in the destruction of part of the initial vitamin C content. Steam for concentration and evacuation is generated by a varieties of oil burning boilers. The natural water being quite hard because of contact with limestone is softened for boiler use by means of zeolite or permutite exchange resins. Economizers and pre-heaters are not everywhere used and the boilers efficiency in general is low.

The vacuum pans of 500 to 1200 l capacity require 1 kg of steam to evaporate 1 kg of water at 2 to 3 absolute atmospheres pressure and are used as batch single stage evaporators, in tandem as two stage operators or as continuous evaporators by adjustment of feed and outflow. The concentrate is pumped from the pan into stainless steel tank of 700 l capacity.

The concentration of the juice is controlled by simple and efficient direct reading refractometers attached to the pan itself. These were designed and made at Prof. GOLDBERG's optical laboratory in Tel-Aviv and are based on an interesting adaptation of the Abbé principle. They are checked against more precise laboratory refractometers at the control laboratory. Temperature correction is made by the use of sugar tables which are not applicable. This error could be avoided by measuring refractive index at the temperature for which the scale was calibrated or by actual determination of the temperature correction for the concentrates of various solids contents. Checking of vacuum gauges, thermometers, refractometers and other instruments is done only in a few plants and more attention should be paid to checking and calibrating instruments. The concentrate is canned usually at several degrees above the specified degree to avoid complaints on this score. Although the specification is for concentrate of 65°Brix uncorrected for citric acid, the corrected value is also determined according to the data of STEVENS and BAIER (Ind. Eng. Chem. Anal. Ed. 1939, 11, 447).

6. Filling, coding and casing

The concentrate is pumped from the pan into stainless steel tanks of 700 l capacity, from which it undergoes again pasteurization at 75°C - 85°C with holding time from 10 - 25 sec. and is then filled hot into plain tin cans. Filling is by means of manually operated filling spouts usually with cut off valves. The cans and lids are sterilized with steam to reduce contamination and the filled cans are closed in Troyer Fox closing machines operated at 2-3 cans per minute. The cans are supplied by the Palestine Can Corp., a subsidiary of Metal Box Co. Ltd., where they are rolled out from flattened bodies made in England. Particular care is taken by Palcanco to assemble the bodies and seam the can manufacture end and these cans are shipped in solid fibreboard cases to the concentrate plants. Little attention, however, is given by the canners to closing and occasionally seams of poor quality result. Loss from this however is surprisingly low or absent. Servicing of closing machines and control of the double seaming operation is in an unsatisfactory state but education of the canners on this is beginning. The cans after closing are tipped off the discharge chute and roll into and through water spray coolers. These coolers are from 4 to 7 meters long, sometimes used in double run, and the cooling is variable and often unsufficient. From the cooler the cans roll over a short labelling conveyor. Difficulty is experienced in obtaining allocation of labels and of paste for labels. The paste used, often made by the canner himself, is improvised from casein hydrolysate, starch, etc.., and to get a good bond must be applied to warm surfaces. The labelled cans are filled by hand into cases in which the allocated cans were received and the cases are closed and sealed by hand. The temperature at which the cans are cased is variable and often too high. The cased cans are then loaded on a truck, in some cases by hand, but usually by fork lift trucks. They are hauled to the shipping ports (Haifa or Tel-Aviv) and may be loaded either at once into refrigerated holds or held in cold storage warehouses until they can be loaded. The temperature to which the concentrate is subjected during transportation to the port and at the port warehouses are not known and there is therefore no-information of the effects of storage conditions on the color, flavor and vitamin C content of the concentrate.

7. Production control

Particular care is taken in controlling the production of concentrate to obtain uniformity of products at all factories. Six of the twelve concentraters have trained chemists supervising production, particularly as to solids content, vitamin C content, viscosity and also as to viable yeast count. The Central Laboratory receives samples regularly for analysis before shipment, but sampling is still unsatisfactory. Uniformity in coding of cans is still unsufficiently enforced and there is still not enough information on variability of composition on the basis of which a more sound sampling procedure could be developed. Steps are now being taken to change the code from a daily one to a batch or holding tank code but economic considerations are involved also. The high cost of No. 10 cans of concentrate precludes taking a large number of samples and sampling procedures which will not involve serious loss to canners and which are still adequate for control must be worked out.

8. Problems in concentrate production

Initially, during the development of concentrate production in Israel, the chief problem encountered was in the heavy contamination of the concentrate with yeasts leading to losses by fermentation particularly during storage and distribution. This condition now has been eliminated through careful control of sanitation since it was found that the most serious cause of infection occured through contamination by duty

equipment in the factory. More care in cleaning the fruit and equipment is necessary and line surveys to determine the incidence of yeast and bacteria at various points are needed but the general precautions which must be taken are known. Lack of detergents and even of alkali required to remove scale and the shifting labor in the plant requiring re-education of both the laborers and operators in cleaning procedures constitutes a serious source of trouble. More important at present is the problem of controlling fluidity and of avoiding gel formation. During the season of 1950 jellification of concentrate owing to the formation of calcium pectinate was encountered occasionally. In 1951 when jellification occured it was due usually to formation of pectin sugar acid jellies. Tests for the ready identification of the type of gelation and for the plant control of pectinesterase activity have been developed. In the Central Laboratory studies are now under way to determine the factors affecting the flow properties (concentration and size and shape of the coarser pulp particles, concentration and type of colloids, pH, cations, etc..) so that concentrates of desired fluidity can be uniformly obtained. The control of bitterness is not as pressing as it is in single strength juice and frozen concentrate production since the British consumer does not object to the slight bitterness in the present concentrate. If it could be solved however so that fruit could be picked and processed earlier in the season, it would enable processing for a longer period with less loss due to Mediterranean fruit fly damage which begins to be pronounced in the latter part of April and May as the daily temperature rises. Although a survey has been made of the occurence of bitterness in the Jaffa orange (Z. SAMISH, The Canner, 1950, 110, Nos. 23, 24, 25) and the effect of cold storage on this, there is still no information on the presence of limonin and the actual limonin content of the fruit tissues. There is need in Israel, as well as elsewhere, for an objective quantitative method of analysis for limonin and its precursor so that serious investigations can be made of the climatic, soil and fertilizer and cultivation practices and of fruit handling and processing practices on control of bitterness. Control of deterioration in flavor, color and vitamin C content of concentrate is also necessary. The possibility of improving the quality and stability of concentrate by reducing heat damage during preparation and storage must be investigated also. Even though the production of low temperature concentrate and its preservation by freezing storage may not be feasible at present, improved concentration and prompt pre-cooling and low temperature storage at the factories and during transportation and storage may be justified. Lack of refrigeration storage and of suitable transportation facilities at present limit developments in this field.

II. SULFITED CONCENTRATE PRODUCTION

The production of concentrated orange, grapefruit and lemon juice for subsequent beverage use is based on the use of sulfite as preservative instead of low temperature or freezing storage. Unavailability or refrigerated storage facilities and the higher storage costs under these conditions have both been involved in this development. The concentrate at 62°Brix after removal from the pan is cooled to 35°C and bisulfite is added to give a concentration of 1500 ppm. The sulfited concentrate has a fair degree of stability only when the conditions are such as to maintain 800 ppm of free SO_2. Investigations in Israel as well as abroad of the conditions governing the preservation of concentrate by SO_2 have been made but more information is needed to improve this procedure. Attention must be paid to reduction in microbial population at time of sulfiting and addition of the most suitable source of free SO_2 under conditions of reduced aeration must be made to obtain best results. The sulfited concentrate must be protected from exposure to high temperatures during storage. Although the factors influencing distribution of SO_2 in the concentrate into various hydroxysulfonates and other addition products and into dissociated and undissociated sulfites are known to some extent more information on this point is necessary. The role of SO_2 in inhibiting microbial development and as an antioxydant are known but its role in controlling the browning reaction still needs to be elucidated.

Sulfited citrus concentrates are exported to Europe and England as a basis for juice production and are very widely used by the concentrators themselves as a basis for their sulfited single strength juice and squash fabrication.

III. SULFITED SINGLE STRENGTH JUICE

The citrus products industry in Israel actually began with the production of sulfited citrus juice some 20 years ago. At that time it was not possible to produce flash pasteurized deaerated canned juice and attention was given to the possibility of producing palatable bottled juices from sulfite preserved juice. At first the juice after extraction and straining was treated with about 700 ppm of SO_2 and stored during the season in bulk for subsequent distribution during the summer months. Separation of the pulp and clearing and clotting of the juice was encountered both during storage and during distribution after bottling. These difficulties now have been largely eliminated and when storage facilities are available considerable quantities of sulfited juice are prepared for summer distribution. The procedure in use to-day depends on the preparation of extracted juice, of low or negligeable yeast content, on the inactivation by heat of the pectic enzymes present and on hot filling of the sulfited juice into sterile bottles. It was observed early that sulfited juice is more resistant to change in flavor on heating than the unsulfited juice and advantage was taken of this to prevent losses during distribution. The procedure at the parent-plant (Jaf-Ora) consists in deaerating the extracted and strained juice, flash pasteurizing at 70°C for 20 sec. and storing after cooling in tile lined concrete storage vats with 700 ppm SO_2 of which ca. 300 ppm are free. Such juice stores well over several months. At the time of bottling the SO_2 content of the juice is reduced below 60 ppm by concentrating it 1:1 in vacuum pans at 45°C. This partially desulfited juice is then mixed with sugar sirup of a concentration sufficient to bring the final product which is made to contain 70 % of single strength juice to 10°Brix. The final product is heated to 73°C and filled hot into clean steamed bottles at 70°C. The bottles are crown capped in semi-automatic cappers and allowed to cool to room temperature in an inverted position. Even after such heat treatment the juice does not have an objectionable heated flavor and the SO_2 taste which at first is objectionable reduces during storage.

IV. CANNED CITRUS COMPOTS

Orange and grapefruit segments are canned in Israel in a similar way as abroad. A rather new development is the canning of orange slices in sirup. For this product the oranges are sliced in a right angle to the core after peeling and removing of objectionable amounts of adhering albedo. The slices have a thickness of 12 mm and eight to twelve slices go into a No. 2 can giving a drained weight of about 400 grams. Sugar sirup is added to make a final concentration after equilibrium of 20°Brix. Sugar sirup is added hot and after exhausting and closing the can is sterilized at 95°C for 15 minutes and immediately cooled afterwards. The slicing of the orange is done in two machines, both developed in Israel. One of the machines is constructed on the principle of rotating knives. The other machine consists of sliced cups, in which the peeled orange is placed, and which are mounted on the outer surface of a horizontally rotating disk. The knives in this case are stationary, cutting the fruit as it passes them and a second disk under the first one carrying the cans allows for the slices to fall directly into them. The main problem in the production of these orange slices which have been well received on the British market is to avoid excessive turbidity in the sirup. The best conditions of blanching and cooling of the fruit to allow for quick and efficient peeling must also be further studied.

V. CITRUS MARMALADES

Marmalades for export to the United Kingdom are made according to British style from strained juice with added shredded peels of different cut. For the local market the peel is added to pulped fruit.

VI. CITRUS BY-PRODUCTS

1. Essential oil

The essential oil present in the emulsion from the Koffler grater or from the F.M.C. machine is separated by centrifuging and usually the separated oil is once more centrifuged after standing for several weeks. It is stored in tinned copper tanks or in glass containers and exported in tin containers. An Israeli orange oil has the following constants :

acid value	0,2 - 0,5
aldehyde as decylaldehyde	1,0 - 1,3 %
N.V.R.	2,0 - 5,0 %
density at 20°C	0,843-0,845
refractive index at 20°C	1,474-1,475

In grapefruit oils the N.V.R. is much higher - from 7-11% - and the aldehyde value is slightly increased. Lemon oil has a higher aldehyde content from 2,3 - 3,5 and an increased acidity from 0,5 - 0,8. A complete analysis of constituents has not yet been made. When kept in completely filled containers with only small headspace stability is good, especially at lower temperatures. Oils from different seasons have however been known to show different storage behaviour and a serious study of this is now on its way in the Central Laboratory. The average yield is 1,0 to 1,5 kg of oil per ton of fruit. This yield represents only part of the oil present in the peel and it is thought that with more frequent cleaning of the Koffler graters preferably by having interchangeable sets, grating performance and oil yield could be substantially increased.

2. Stock feed

The peel in smaller plants is either sold fresh for stock feed or disintegrated and fermented for alcohol production. In larger plants, having drying facilities (either direct fired rotary kiln dryers or steam heated rotary dryers) the peel after chopping or disintegrating is treated with lime at a rate of about 1 kg per ton, mixed and held for dewatering, and then pressed. The pressed pulp is fed into driers and converted into dry citrus meal.

3. Alcohol

The peel juice from the limed peel and in some plants the ground peel is fermented and distilled to recover alcohol. Three plants of the Association have alcohol factories attached to them. Due to enzymatic saponification of the pectin of the peels even the rectified alcohol contains up to 2 % methanol. Under the mandatory government this alcohol was admitted for drinking purposes but now under the Israeli government this alcohol may only be used as industrial alcohol.

4. Others

Attempts were made for limited production of citric acid from lemon, naringin from grapefruit and of pectin. At present only a limited amount of crude pectin is made by drying the whole leached peel and

washing it with alcohol. Attempts to produce a mixed pectin - cellulose by acid alcohol hydrolysis of dried peel according to HIRSCH's patent (U.S. 2,008,999) were not successful economically because of high price of alcohol. However pectin production is now definitively on the production program of the Association after a small pilot plant has been run successfully at one of the factories making use of a fabrication process worked out at the Central Laboratory. Because of the critical shortage of organic acids and of sugars, attention is being given to production of lactic acid from citrus peel and other sources (such as whey), to the development of aspergillus niger fermentation citric acid and to production of table sirups and beverage bases from citrus peel juice. Feed yeast production was also investigated. Studies are under way at the Central Laboratory to produce pectinase on a pilot plant scale from submerged mold cultures to provide the concentrators with this enzyme which may help them to overcome viscosity problems in concentrates not destined to be reconstituted.

The most justifiable balance between various citrus by-products is influenced by local conditions, and products and processes which have been tried and discarded as uneconomical in the U.S.A. and elsewhere may prove to be worthwile. Experience gathered in continuous large scale production of these will lead to modification and adaptation of existing information as well as to new developments which may well result in technological advancement of importance to the citrus industry of the world.

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XVII. THE CANNING INDUSTRY IN MOROCCO

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I. THE FISH CANNING INDUSTRY

The fish canning industry in Morocco has taken a great step forward in recent years and now constitutes one of the major activities of the country. It is one of the principal producers and exporters of Morocco. This situation is the result of the natural suitability of the country and the abundance of commercial fish found in Moroccan territorial waters.

1. Fishing

The rational exploitation of the fishing industry produced the following catches :

1938		1950	
Sardines	18,000 tons	Sardines	109,000 tons
Tunny	4,500 tons	Tunny	2,275 tons.

2. Number of factories

Following on the increase in fishing the fish canning industry has developed correspondingly and the increase in the number of factories is particularly significant :

1926 .... 14 factories,
1938 .... 44 factories,
1950 .... 197 factories.

More characteristic still is the industrial development of the ports in the south (Safi, Mogador, Agadir).

Safi which had 16 factories in 1939 now has 64.

Agadir which in 1939 had only one factory now has 54 actually working or in course of construction.

In these last few years 10 factories have been established in Mogador.

3. Production of canned fish

The production of canned sardines in oil for the years 1938 and 1950 (expressed in cases of 100 1/4 club 30 cans) is evidence of the increasing activity of the canned fish industry in Morocco.

1938 .... 590,000 cases,
1950 .... 2,300,000 cases.

This latter figure represents a semi gross weight of 43,700 tons of canned sardines to which must be added 1,820 tons of canned tunny in oil. The total value is nearly 10 milliards of francs. Other canned fish and shell fish which are packed in Morocco such as mackerel, shrimps, etc., are only of small importance.

4. Technical improvements

It is well to stress the efforts made by the Moroccan canners to increase the yield of the fishing industry and to improve their equipment and methods of working. To this end the Moroccan canners set up a company which uses a trawler specially equipped for the methodical examination of the sea and for putting into practice scientific methods for detecting shoals of fish.

On the industrial scale the ever increasing tendency to greater mechanisation in the handling of the fish must be noted.

The number of automatic lines for cooking, drying, oiling and seaming increases steadily. There are at the present time in Morocco 14 automatic I.M.C. (International Machinery Corporation) lines, 330 and 430, and five automatic Mather and Platt lines. These figures need no comment.

The principle of this method of packing raw into cans and the characteristics and functioning of the equipment used have been well described by Mr. BOURY at the International Congress for the Study of Fish as Food and by Mr. ROSKIS in the August 1950 number of l'Officiel de la Conserve. It is therefore not necessary for us to describe once again this well known equipment nor to point out the advantages from the economic, technical and hygienic standpoints which result from this method of cooking the fish in the can.

On the other hand we think that it would be useful to describe in more detail a new automatic machine for the manufacture of canned sardines by packing raw in the can which was shown on the 20th December, 1950, by its inventor Mr. Daniel BONNEFON, a canner at Agadir.

The principal characteristics of the Bonnefon machine can be summarised as follows :

The equipment consists of two sections, a heat exchanger providing the heat and a cooking and drying oven. The method of heating is by hot air produced from a heat exchanger fired by an oil burner. The hot air produced is carried to the cooking oven and to the drying sections by a large capacity fan and is circulated inside these ovens by a mixing fan. The consumption of fuel is about 8 litres per hour.

The cans filled with fish for cooking are introduced by means of a charging mechanism running on rails.

The oven is fitted with a rotating member manually operated which after a suitable time for cooking is moved through a quarter of a turn to allow the water cooked from the fish to drain away. The hot air circulating at high speed pre-dries the contents of the cans.

The drying is thus accomplished the loading mechanism taking up successively three positions while turning round as axis. At each movement which takes place every 12-15 minutes, a carrier of dried and cooked fish is withdrawn and replaced by one with raw fish.

The temperatures in the ovens are recorded by thermometers placed on a central control panel and the times of loading and unloading are regulated by a minute clock.

Each carrier holds 396 1/4 club 30 cans and the output of the machine is therefore 16-20 cases per hour according to the cooking time.

The machine requires two workmen only to operate it.

The construction is of the "Monobloc" type so as to permit of easy handling, and all the inside parts of the oven are covered in stainless steel as also are the carriers.

It has been found that it is more advantageous to use several standard machines (16-20 cases per hour) rather than one higher output machine based on the same model.

The results obtained during manufacture have shown a marked saving in both labour and power in comparison with manufacture by traditional methods. Furthermore, the technique of cooking and drying ensures that the production can be very carefully controlled because of the possibility of a very accurate regulation of the temperatures of cooking and drying.

Elsewhere the cooking of fish by infra-red radiation has been tried several times in Morocco.

Finally, quite recently two automatic beheading and eviscerating machines have been put into service in Morocco but it would be premature to make any comments on the results obtained.

As will be seen from the description of the plant used, the Moroccan fish canning industry is very proud of possessing the most modern and highly developed equipment and is consequently making every effort to justify the high reputation of its products on world markets.

II. THE VEGETABLE CANNING INDUSTRY

The utilisation of the products of the Moroccan soil has been carried out methodically and is developing satisfactorily.

Favoured by its exceptional climate, temperate and with plenty of sunshine, Morocco has become a large producer of early fresh vegetables which find a place on export markets because of their quality and their early maturity.

The increasing production of agricultural products has resulted in a parallel development in the manufacture of vegetable products and at the present time Morocco has almost 80 factories for canning vege-

tables which are officially approved by the Services de l' Office Cherifien de Controle et d'Exportation.

The chief products canned are peas, tomatoes (concentrated and peeled) and to a lesser extent green beans, artichoke hearts, spinach, mushrooms, sweet peppers, macedoine, etc...

1. Canned peas

Among the canned vegetables peas take the first place.

The quality of Moroccan peas results in a product which sells extremely well on many different markets but particularly in England. Thirty-one factories are officially approved for the manufacture of this product.

In 1950 65,000 cases (each 50 1/1 cans) were produced and it reached 120,000 cases in 1948. Variations in the size of the crop explain these variations in production.

Machinery

A certain number of approved factories possess modern machinery and continuous canning lines.

Viners are not used in Morocco where picking is done by hand, and it would appear that this contributes in a large measure to the quality of the final product.

The larger factories have large capacity podders (5 tons per hour) brine graders and continuous cookers.

The stationary cooling of peas after cooking is often carried out. These same factories have hot brining equipment as well as automatic filling machines, and they also cool the cans under pressure.

2. Tomato concentrates

The number of factories approved for the manufacture of tomato puree was 21 at the 1st July, 1951, and these are capable of producing several thousands of tons of concentrates. The quality of the tomatoes used, the method of manufacture, and the standards imposed make certain that the production is of very high quality.

The commercial production of tomato puree is frequently carried out in conjunction with the manufacture of tomato juice, and because of this a certain number of operations are common to both products (washers, graders, crushers, and hot breakers). The concentrating line then follows consisting of sieving machines and, in certain Moroccan factories, double effect evaporators followed by a stainless steel italian "boule". After pre-heating the product is filled hot sometimes by means of I.M.C. machine (6-8,000 cans per hour size 1/6 and 1/12) and the sterilisation of the contents of the cans is carried out by a cooker cooler F.C. II (Carvallo).

3. Peeled tomatoes

The Moroccan industry produces annually large quantities of canned peeled tomatoes for Great Britain.

The factories producing these use the normal equipment of vegetable and tomato puree canneries.

4. Other canned vegetables

The production of canned green beans and artichoke hearts is increasing.

These products, particularly green beans, are being sold abroad and are getting a permanent market because of their quality.

III. THE FRUIT AND FRUIT JUICE CANNING INDUSTRY

1. Fruit juices

The construction of the first factory for fruit juices in Morocco goes back to the year 1939 and at that time the intention was to produce only for local consumption.

The growth of this industry dates in fact from 1946 - 47 and Morocco then has about 20 factories of various sizes producing fruit and vegetable juices.

The difficulty of finding external markets which are indispensable to an expanding production has caused the disappearance or closing down of the smaller factories and on the 1st January, 1951, eight modern factories shared the production of fruit juices in Morocco. The following figures show the result of the 1950-51 season :

a) Production

	Tons
Citrus juice	1248
Tomato juice	241
Total	1489
Export .... Total	550
Local consumption (for the fresh market	98
Local consumption (for industrial uses	621
Total	719

Production capacity

The fruit juice industry in Morocco is capable of producing under ideal conditions more than 7,000,000 litres of various juices per year.

b) Equipment

The eight fruit juice factories possess most up-to-date equipment as will be seen from the following list of the modern plant which they use. (Whenever possible the numbers of each machine in use has been given in brackets) :

- Automatic washers,
- Burton graders,
- Chisholm Ryder crushers,
- Preheaters before extraction (hot break),
- Chisholm Ryder finishers,
- Homogenisers (3),
- Deaeraters (6),
- Flash pasteurisers (6) - (Alfa-Laval, Corblin, F.M.C.),
- American automatic juice fillers,
- American automatic seamers (7-14,000 cans per hour).

For the manufacture of orange juice seven automatic Colin R.A. 12 extractors are used in one important Moroccan factory. These are the last word in French technique as far as equipment for citrus juice extraction is concerned.

2. Canned fruit

The canned fruit industry in Morocco thanks to new outlets is increasingly active. At the 1st July, 1951, 80 fruit canning factories (pulp, jams, fruit in syrup) were approved in Morocco by the Office Cherifien d'Exportation.

The statistics for the 1950-51 season give a fairly exact idea of Moroccan production :

Citrus products	a) Citrus pulp	750 tons
	b) Oranges in syrup	3250 tons
Apricots	a) Apricot pulp	1900 tons
	b) Apricots halves	2400 tons
	c) Apricots in syrup	400 tons
Various jams		1000 tons (approx.).

As far as other fruits, such as plums, peaches, quinces, figs, etc... are concerned, commercial production only represents a very small tonnage.

Equipment

The modernisation of the fruit canneries which was begun some years ago is proceeding steadily.

Most factories producing citrus pulp use Dundee cutters as well as machines for cutting and removing pips from oranges.

Apricots canning factories frequently use automatic stoning machines.

Exhausting is generally practised as is continuous sterilisation at 100°C. Some factories possess continuous blanchers.

The Moroccan jam industry continues to use traditional methods of manufacture in open pans.

At last, stainless steel is replacing little by little other metals in the canned fruit and jam industry.

IV. THE MEAT CANNING INDUSTRY

The importance of the meat canning industry in Morocco although much less than that of canned fish, vegetables, or fruits is still not negligible.

The increase in the number of factories during the last 12 years shows the effort made to utilise the resources of the Morroccan livestock industry.

In 1938 there were only three meat canning factories but at the present time 13 share the production of this branch of canning. Their total productive capacity is estimated to be 8/10,000 tons per annum.

The production of these factories is intended to supply as a first priority the needs of local consumption which have increased considerably since 1940. But the productive capacity exceeds greatly the potential requirements of the Moroccan market and the industry is henceforth turning towards export (425 tons in 1950).

It is worth while recalling the essential part played by the meat canning industry of Morocco in supplying the French armies in Tunisia and Italy in 1944 and 1945. For the year 1945 alone more than 5,000,000 cans of spiced beef and cooked dishes were manufactured for the Army in the most important factories in Morocco.

These factories are equipped with first - class machinery, with high output lines for meat canning and the care given to keeping them up-to-date has been exemplified recently by the installation in several of them of retorts fitted for pressure cooling. It is also important to note too that the cold storage equipment of the Moroccan factories has been completely overhauled during the last years and they have been fitted with the latest improvements in refrigerating plant.

Moroccan production is equally remarkable for the variety of canned foods prepared to which has recently been added the manufacture of canned cooked hams packed under vacuum.

XIX. RECENT TECHNICAL PROGRESS IN THE PORTUGUESE CANNED FISH INDUSTRY

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This report is only concerned with canned fish although there are many interesting things which could be said about the progress in Portugal during the last few years in equipment and manufacturing methods of the meat, fruit and vegetable canning industries. We will simply say that in almost all the tomato concentrate factories old fashion copper plant has been replaced by stainless steel, existing factories for canned fruit and vegetables have been improved, and large new plants for meat canning, equipped on modern lines haves been built.

However we will only consider canned fish, since the production is so much larger than that of any other type of canned food in Portugal and is of a very great economic importance.

The remarks which follow are concerned principally with sardine canning since this occupies the first place. More than 80 % of the production of canned foods in the country consists of sardines in various forms (in oil, boneless, boneless and skinless, in tomato sauce and stewed). The remainder of the production is spread over other types of product, anchovies, tunny, sprats, mackerel, shell fish, hors-d'oeuvres, etc.

It should be noted that the production of sardines in Portugal is based entirely on the foundation of a high quality pack, that is to say a first class product as compared to a lower quality mass produced one. There is no desire to compete with other canned fish which pretend to have similar characteristics to the sardine prepared from "Clupea pilchardus" according to the typical Portuguese method.

This is the reason why the mechanisation of the sardine canning industry has not been more developed. The use of automatic machines and conveying equipment involves in most cases a treatment of the fish which is incompatible with the desired quality in the finished product.

We shall give concrete examples of what we have just said. In the notes which follow we will describe the manufacturing operation dividing our paper into two parts as was asked for by the C.I.P.C. It is evident that we can only give a short resumé of a subject which could be discussed at much length.

I. PROCEDURES, METHODS OR EQUIPMENT CONSTITUTING A NOVEL DEVELOPMENT AND WHICH HAVE FOUND PRACTICAL APPLICATION IN INDUSTRY

1. As regards the beheading and evisceration of sardines, the machines used for this purpose in other countries for herrings and other fish have been tried. The special quality required by the Portuguese canning industry has not enabled the use of these machines to become general.

2. The initial treatment of the sardines is now being done in certain canneries on special long tables (25/50 metres) provided with channels and designed so that the reception of the fish, beheading, evisceration removal of waste, washing, brining and placing in trays can be done more quickly and more efficiently.

The original model of these tables, patented by the Spanish firm of Masso was modified in Portugal so as to obtain better brining conditions (according to the different sizes of fish handled) and also to avoid as far as possible any bruising of the fish which might spoil its appearance.

3. All the trays used for cooking the fish which previously were coated with an alloy of tin and lead are now coated with pure tin so as to avoid any contamination of the fish with lead. The trays are retinned at least once a year.

4. The trays are now washed in a spray washing machine which enables them to be handled more rapidly and more effectively.

5. Hot air tunnels (Masso system) have been used in place of cooking in steam boxes, but they are still at an experimental stage.

6. The drying of the sardines after cooking is now carried out in forced draught tunnel driers.

7. The addition of oil after the sardines are packed in the can is in some cases done by means of automatic machines.

8. Finally after sterilising, the cans are washed in machines of high output thus doing away with hand washing as previously carried out.

II. MODIFICATIONS AND DEVELOPMENTS IN TECHNICAL EQUIPMENT WHICH ARE NOT REALLY NOVEL

1. The first point to be brought out as regards the modernisation of production is the improvement in the hygienic conditions of the equipment and the work. To this end the industry has built new factories or reconditioned old ones, specially designed for the purpose in view.

Detailed regulations and a strict control have ensured that the stipulations laid down for the following are obeyed.

a) Buildings, e.g. waterproofing and coating of walls, tiling of floors, lighting, ventilation, etc..

b) Hygienic conditions and methods of working, e.g. clothing and hygiene of the workers.

c) Plant and equipment, e.g. marble tables for beheading and packing, etc..

The handling of fish waste in the packing factories is forbidden and modern plants for the manufacture of fish meal and oil have been built.

The control over the finished product before sale has been increased and improved by means of quality examinations. This work is carried out by specially qualified technicians, and thanks to an increased analytical chemical control carried out in the laboratory of the Portuguese Institute of Canned Fish.

An example of the practical efficiency of these methods is shown by the complete elimination of lead, which used to be found, sometimes, although in very small quantities, in Portuguese Sardines, as well as in those of some other countries.

The increased size of the canneries and the use of greater numbers of more modern machines and equipment has given rise to a corresponding increase in the production capacity of each factory and in consequence of the total Portuguese canned fish industry.

2. In the initial treatment of the fish certain beheading methods have been discarded since they did not allow of complete removal of the viscera. Only fresh clean brine is used and much more care is taken in washing the fish.

3. Only trays made of iron wire are used instead of other non-metallic types, which were used originally in the industry. The height of the trays has been altered so that fish of various sizes may be handled. Tables for packing into trays have been modified so as to give more hygienic and more rational conditions of work for the packers.

4. The characteristics of the Portuguese system of manufacture of sardines is the cooking of the fish in steam ovens instead of the frying in oil; still done in some other countries, but completely given up in Portugal. The use of steam for cooking goes back to the last ten years of the 19th century. The ovens which are in steel have been modified and improved from time to time as regards dimensions and means of opening. The cooking operation has become more uniform, the appearance of the fish better, and to this end all the cooking ovens have been provided with the necessary equipment for control of the temperature and pressure of the steam. The use of these cooking ovens for sterilising the filled cans has been forbidden so as to avoid any possibility of the contamination of the sardines by lead which might come from the inks and varnish on the outside of the filled cans.

5. The drying of the cooked sardines has received special attention particularly as regards to where it is carried out, so as to avoid contact with dust. Drying of the fish in the open air is forbidden unless special hygienic conditions are followed and for the most part drying tunnels with a forced draught of air are used.

6. The empty cans are now made with more care. The use of drawn cans and cans with both ends seamed on has become general, chiefly for sardines packed without skin and bone.

The packing tables have been re-designed so as to give better conditions of hygiene and easier packing.

7. Previously the addition of oil to the cans filled with fish was carried out by stacking them in containers which were then filled with oil so as to cover the cans. This brought the oil in contact with the outside of the cans and there was a risk of introducing undesirable substances into the product. That is why it has begun to be done either by pouring oil into the cans or by automatic machines. The immersion of the cans in oil has been forbidden.

8. In the early days of the industry the filled cans were closed by hand soldering. The process which was slow and unreliable has for many years been replaced by seaming machines. The first seamers used were hand operated and had only a small output but remarkable progress was made with the introduction of semi-automatic seamers (Matador type) which closed 900 tins per hour.

The modern seamers installed now-a-days in all Portuguese canneries where usually some of the old machines are still held in reserve are entirely automatic and work at high speeds reaching several thousands of cans an hour.

The ends of the cans are lined with a rubber ring put in place by automatic or semi - automatic machines. This ensures the air tightness of the cans. Today rubber rings have been replaced in many canneries by the use of liquid lining compound consisting of a solution of rubber in benzene or by an emulsion of the rubber in other liquids. This joint is spread in a thin and uniform layer in the flange of the end by special machines and the ends are then dried in ovens.

9. The sterilising of the filled cans in boiling water has been replaced by the use of steam heated retorts, nearly all of them used today being of the horizontal type with a door through which cages on wheels can be introduced. They replace the vertical retorts which necessitated the use of hoists for putting the filled cages of cans into them. It is obligatory to equip all retorts with control apparatus, e.g. thermometers, pressure gauges, safety valves, etc...

XX. RECENT DEVELOPMENTS IN FRUIT AND VEGETABLE CANNING IN GREAT BRITAIN

by F. HIRST, Director, and W. B. ADAM, Deputy-Director
Fruit and Vegetable Preservation Research Station, University of Bristol (United-Kingdom)

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The developments which have taken place in the fruit and vegetable canning industry since the recent war are dealt with in the present article under four headlings; Output, Quality, Raw Materials, and Plant and Machinery. Fruits and Vegetables are kept separate, though in some instances certain features are common to both.

I. FRUITS

1. Output

Wartime restrictions, which were in force up to and including the year 1946, prohibited the canning of most soft fruits. An effect of the gradual recovery in acreage of strawberries and raspberries since 1946 has been to encourage an increase in output of these fruits in cans, but the return of canned soft fruits to the shops has made it increasingly difficult to sell canned rhubarb, which was popular for a few years when other fruits were not obtainable. Plums of a number of different varieties, including damsons and green gages, still constitute the most important pack of fruits canned in England. The total output of canned fruits, stated in terms of nett weight of contents, was 21,700 tons in 1946 and reached 89,100 tons en 1949, from which peak figure it fell somewhat in 1950, owing to shortage of supplies of empty cans.

2. Quality

From 1930 to 1939 the only official standard of quality in Great Britain was that associated with the National Mark, which formed part of a voluntary scheme instituted and operated by the Ministry of Agriculture for the better grading and marketing of agricultural and horticultural produce. The Mark was widely used in the canning industry and helped to establish a fairly high level of quality in the produce of firms which used it on their labels. The scheme was withdrawn at the outbreak of war in 1939, but minimum requirements for filled weights of fruit and standard syrup densities were soon prescribed by the Ministry of Food and these regulations still remain in force. In 1946 the fruit and vegetable canners agreed to recognize

certain tentative standards of quality and to submit samples of their packs to the Campden Research Station where each is examined and placed in its appropriate grade. Canners receive reports on each sample submitted, a report at the end of each season on the whole of their own pack, and a summary of the reports on all packs examined. In the latter report, under the heading of each class of fruit, the canners are shown in order of merit, each canner being indicated by a code letter known only to himself. About 4000-5000 cans of fruit are examined annually.

3. Raw Materials

a. Fruit

To help to recovery in acreage of strawberries and raspberries from the low levels they hand reached during the war many new varieties were produced and grown on experimental plots. The most promising of these were given canning trials at the Campden Research Station and a few have been used in canneries. The most interesting new strawberry is Auchincruive Climax, a variety introduced by the Scottish Department of Agriculture, which has been consistently good in the canning trials and has proved acceptable also on the fresh market, and for quick-freezing and jam making. During the war more than a thousand new strawberry seedlings were raised at the Horticultural Research Station at Cambridge, and about seven hundred of these were grown at the Kingsley Fruit Farm and Nursery, near Borden, Hants. Canning trials on 40 - 50 of these new Cambridge varieties have been in progress at Campden during the past four years, though none has yet been passed as fully satisfactory for canning. Canning trials have also been made with several new varieties of raspberries introduced by the East Malling Research Station, which have proved successful when grown for the fresh market. Unfortunately none of these varieties has given as good results as the commonly grown Norfolk Giant, or as the once popular Lloyd George. Although several new varieties of other fruits have proved to be very satisfactory for canning none has been really outstanding, and growers, and canners prefer to keep to the ones which they known by experience to give good results.

b. Cans

Before the war there was a move towards using cans which had been lacquered after fabrication, thus greatly reducing the area of metal exposed to the action of fruit acids and increasing the shelf life of the cans before they become hydrogen swells. Several methods, such as spray lacquering, flush lacquering, and electrodeposition of lacquer, had been tried but the practical problems involved prevented the adoption of any of these after the war. Instead a "Long Life" can was introduced by the Metal Box Company in which the side seams were side-striped with lacquer after fabrication and the ends protected either by spray lacquering the shoulder or by using a lacquer which was very resistant to fracture for the initial roller coating. These cans have not yet been widely used on account of the slight increase in price. Experiments are now in hand at Campden with the object of testing aluminium, treated in various ways, as a metal for fruit cans. Most previous efforts in this direction have proved unsuccessful, but one method of treatment of the plate has given fairly promising results in the present tests. These cans must be lacquered after fabrication and much depends on the efficiency with which this operation can be conducted.

4. Plant and Machinery

a. Grading

Mechanical grading of gooseberries, cherries, plums and damsons was commoner before the war than now, though the practice is gradually gaining favour again. No striking new developments appear to have taken place in this field.

b. Peeling

Plums are not only the most important fruit canned in Great Britain, but are the most subject to disfiguring forms of skin blemish. It was therefore considered necessary to examine the possibility of peeling these fruits before canning, and many experiments directed towards this end were conducted at Campden. Steam peeling, brine peeling, and lye peeling were examined, and successful results were obtained with the last of these methods, but it was found necessary to vary the process considerably, as regards time, temperature, and concentration of the lye bath, according to the variety and ripeness of the fruit. More promising results were obtained when a method of flame peeling was introduced by Messrs. Pickering's Produce Canners Ltd. of Stockport in which the fruit passes for a very short period (generally 15 - 30 seconds) through an electric conveyor furnace, the skin being scorched but the time of application of the heat being too brief to allow appreciable conduction of heat below the layers in immediate contact with the skin. The fruit then passes under pressure sprays and, in some cases, may be given mild abrasion to remove the last traces of skin. Plant working on this principle, and known as the Universal Thermo-Peeler, is marketed by Mather & Platt Ltd. It can deal with two tons of apples or pears an hour, operates at temperatures up to 1000°C giving periods of 10 to 60 seconds in the heat zone, and uses a full load power consumption up to 230 KW. Plums, apples, pears, peaches, grapes, apricots, tomatoes, onions, potatoes and carrots may be peeled in this plant which includes, in addition to the peeler, a rod washer and a trimming table.

c. Filling

No striking advances have been made towards high-speed automatic filling of cans with fruit. With

d. Vining

Improvements have been made in the design of viners, including the use of tapered drums in which the peripheral speed of the beaters and the area containing peas haulm increase progressively. The pods receive a light blow to start with, which becomes progressively harder as the vines work their way down the machine. There is also a new arrangement for teasing out the vines so as to avoid peas becoming entrapped and discharged with the haulm.

e. Elevating the Peas

In some canneries the peas are lifted up to heights of about 30 feet in quantities up to 5 tons an hour by means of a centrifugal pump. Control is obtained by the use of a variable speed gear and the peas are not only lifted without damage but are given a thorough wash through the turbulence set up in the impellor.

f. Washing

The importance of reducing bacterial infection to a minimum before canning has been increasingly realized by canners as a result of work done at Campden, and greater attention in now given to efficient washing. One of the new types of washers recently installed in several canneries is the Stero-washer, designed and made by Mather & Platt Ltd. It consists of an enclosed vertical bucket elevator with sprays of water directed downwards from the top, an arrangement of sprays directed from the side at a point about one-third of the way down turns the peas over in the buckets. This method of washing is by counter - current and has been shown to be more efficient for a given flow of water than the methods commonly in use. Another new type of pea washer combines the principles of the standard Duo washer and the Stero - washer. It has an automatic self-cleaning riffle section, followed by settling tank and sludge chamber from which the peas pass through a rod washer to eliminate splits and skins and then to a Stero-washer.

g. Hydro system for Peas

This system -designed by Mr T.M. Jones of Mitchell Engineering Ltd.- represents an interesting new development in pea canning the object being to produce a continuous flow of operations from the initial washing and removal of stones and dirt to the final stage before filling, eliminating all moving parts (except in grading and blanching) such as bucket elevators, inspection belts etc.. The whole plant is irrigated by the flow of water which carries the peas from one stage to the next, steam injection elevators being used where the peas have to be lifted, and inclined " flights " of overlapping slats to separate the sound peas (which bounce over the slats) from splits, skins and wash water which fall between them. The sequence of operations is as follow :

a) stones and separator;
b) sump;
c) flight;
e) sump;
f) steam injection elevator;
g) flight;
h) inspection flume (where the peas pass in a shallow stream, revolving as they go);
j) graders;
k) inspection flume;
l) blancher;
m) inspection flume;
n) flight;
o) filler.

The plant, which is of stainless steel, is arranged on two levels with most of the main operations (including inspection) on the upper deck. All parts are easily accessible for cleaning. This system was worked successfully at one cannery in 1950 for fresh peas and has since been operated at another cannery for processed peas. The waste waters from the later operations are returned to the food end of the feed unit and are discharged to waste after the first "flight". The total quantity of water used is at the discretion of the canner, but need not be excessive. The system may also be used for cleaning peas at vining stations where ample supplies of water are available, lifting of the peas being by water injection instead of by steam injection.

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XXI. DEVELOPMENTS IN THE FISH CANNING INDUSTRY IN THE UNITED-KINGDOM DURING THE PAST 10 YEARS

by J. G. HUNTLEY
Deputy-Director, Research Division, Metal Box Co (United-Kingdom)

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I. PRODUCTION

The fish chiefly canned in the United Kingdom are the herring, the brisling or sprat and the pilchard; other fish products which are packed in cans to some extent are Cod Roe, Herring Roe, Kippers and Fish paste of various sorts. The relative importance of these products may be gauged by the following approximate figures for numbers of cans of each products packed in 1950.

Herrings	43.000.000	Pilchards	5.000.000
Brislings	6.000.000	Kippers	2.000.000

These figures represent quite a market increase over the pack in 1939 but the only product which can be regarded as having become newly established since that date is the pilchard which is caught and canned along the coasts of Devon and Cornwall.

II. HERRING CANNING

The traditional way in which herring is canned in the United Kingdom is that in which the raw fish is packed with tomato puree in the can or to a lesser extent the raw fish alone without any other addition. There has been little deviation from this practice except in some few instances when vinegar and or various spices have been added to the tomato puree or when other sauces such as mustard sauce, or vinegar have been used. The latter products however, have not found any very wide acceptance. The flat oval or rectangular can continues to be used for herrings to the exclusion of the round Open Top can which has never been adopted because of the greater liability of the contents to damage in transit and to the greater difficulties of packing and greater wastage of fish.

Mechanical degutting has now been almost universally adopted and modern machines have a good performance necessitating relatively little inspection or trimming of the eviscerated fish. These machines remove the head and guts only, the tail being left. The fish are then held in saturated brine for periods of about half - an - hour but this operation is still done in batches in large tanks, no satisfactory continuous brining equipment having yet been developed.

The weighing and packing operation is a hand procedure but packing tables are now used to which the cans are delivered by conveyors and which are preceded by a machine which adds the required amount of sauce to the can. After filling, the ends are then loosely clinched on to the cans and during the last few years machines operating at speeds of 60 c.p.m. have been developed.

The cans are then passed through a steam heated exhaust box for 15 - 20 minutes before the final seaming, this method of obtaining a vacuum in the can having entirely replaced the method of vacuum seaming or brogging which was used to some extent before the war. No draining of the packed can after exhausting or pretreatment of the fish before packing is used.

No new developments in the seaming or retorting of fish cans has occured other than the general adoption of temperature controllers on the retorts and water pressure cooling and of some method of sterilising the water by chlorination.

Labelling is entirely carried out by hand for both the body and top label but, automatic machines are in process of development.

Some experimental work has been carried out on draining the canned fish after exhausting to remove the separated liquor and also on the grying of the fish before closing the can but no commercial use has been made of these techniques. Fully automatic equipment for this purpose made by International Machinery Corporation, S.A., 3, Breedstraat, St Nicolas-Waes, Belgium, and Mather & Platt Ltd, Radcliffe, Lancs., has been tested.

III. PILCHARD CANNING

The methods employed are generally similar to those used for herring but about one quarter of the pack is put up in round cans the rest being in oval ones. A certain proportion is also drained after exhausting to remove separated liquor and some fish have been smoked before packing. The fish are usually scaled in an abrasive rotary scaler before degutting and contrary to the practice with herring the degutting machine is usually adapted to remove the tails as well.

IV. BRISLING CANNING

The brisling pack goes almost entirely into the 1/4 Dingley can and is packed mainly in oil and to a small extent in tomato sauce. The method used in England is similar to that in Norway where the fish are scaled and brined and then smoked and beheaded without degutting. They are then packed, in the can by hand the oil or sauce added and the cans closed and processed without exhaust. The only major change in these processes which has taken place is the replacement of the old batch smoking kiln by an improved type of smoking kiln developed by the Torry Research Station, Aberdeen (D.S.I.R. Food Investigation Leaflet N° 10. The Torry Research Station, Controlled Fish-Smoking Kiln).

In this equipment the smoke is generated in a separate unit and passed at controlled temperature and humidity over the fish which are so placed in racks as to get a uniform treatment throughout each batch.

This smoking arrangement is also being used to a considerable extent for the production of kippered herrings both for the fresh market and for canning. In canning kippers the brined smoked herring is placed in an oval can with a layer of parchment between each fish; the cans are then either exhausted or vacuum closed without further addition and processed in the same way as are canned fresh herrings.

XXII. CONFITURES EN BOITES DANS LE ROYAUME-UNI PROGRÈS TECHNIQUES RÉCENTS

par M. OLLIVER, M. Sc., F. R. I. C. et W. E. RHODES, M. A.
Chivers & Sons Ltd, (Royaume-Uni)

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I. INTRODUCTION

Il y a lieu de souligner que, malgré l'importance de la production des confitures et marmelades dans le Royaume-Uni — environ 350.000 tonnes en 1950 — la proportion qui est conditionnée en boîtes est très faible.

II. RÉCIPIENTS

Les formats des boîtes habituellement utilisés pour les confitures sont les suivants :

Désignation commerciale	Diamètre intérieur en mm	Hauteur hors-tout en mm	Contenance en ml
1-lb. Jam	74	90	362
2-lb. Jam	99	102	742
7-lb. Jam	153	148	2.543

La plupart de ces boîtes sont à deux fonds sertis. Les boîtes de 1 et de 2 livres sont surtout exportées, tandis que celles de 7 livres, ainsi que des bidons de 28 livres à couvercle mobile, sont généralement vendus aux pâtissiers et confiseurs.

Des tentatives ont été faites pour introduire sur le marché de détail intérieur des boîtes à couvercle coiffant. Ces boîtes étaient souvent agréablement illustrées, mais leur emploi a posé des difficultés techniques et de production qui n'ont pas été entièrement vaincues, et en définitive la boîte ne paraît pas avoir su gagner la faveur des consommateurs aux dépens du bocal.

III. TYPES DE FRUITS

Les principaux types de confitures et marmelades que l'on prépare au Royaume-Uni sont celles de : cassis, prunes, framboises, fraises à partir de fruits locaux, et d'abricots, d'ananas et d'oranges à partir de fruits importés. Pour les marmelades d'oranges on emploie à peu près régulièrement des oranges amères ou du type Séville. On prépare trois types de marmelades d'oranges : à coupe épaisse, à coupe mince, termes qui se rapportent l'un et l'autre à la forme sous laquelle l'écorce est présentée, et la "Jelly marmelade" (gelée d'oranges) qui contient uniquement une faible proportion d'écorce répartie dans une gelée ferme. Chaque fois que cela est possible, on s'efforce de satisfaire la demande du public qui recherche des confitures renfermant des fruits entiers ou relativement entiers; mais certains fruits, comme les framboises, se prêtent évidemment mal à la conservation à l'état de fruits entiers, tandis que d'autres, comme le cassis et la groseille, sont généralement présentés sous la forme de gelées transparentes.

IV. MÉCANISATION DE LA FABRICATION

Des progrès considérables ont été accomplis au cours de la dernière décade dans la mécanisation des unités de production, et bien plus nombreux sont aujourd'hui les constructeurs de machines qui s'intéressent aux besoins des confitureries. Pour la préparation des oranges pour la marmelade, qui demandait jadis une main-d'oeuvre considérable, il existe aujourd'hui des machines qui enlèvent l'écorce par quartiers et séparent la pulpe des pépins. Cette machine est donnée comme pouvant travailler 700 lbs (317,5 kg) d'oranges à l'heure et économiser 90 % de la main-d'oeuvre par comparaison avec le pelage à la main. Cette économie est obtenue dans une certaine mesure au détriment de la qualité du travail, et il reste ensuite le problème de la séparation des pépins qui sont entraînés avec les écorces. Encore à propos de la préparation des fruits on peut signaler qu'un modèle amélioré de dénoyauteuse à cerises importé du continent est employé avec succès pour le dénoyautage, aussi bien des cerises que des prunes.

Des systèmes à air comprimé ont été introduits avec d'excellents résultats pour transporter les fruits et les pulpes de fruits d'une partie à l'autre des usines, tandis que la manutention du sucre a été rendue plus facile et la qualité des produits finis notablement améliorée en utilisant cet ingrédient sous la forme de sirop filtré.

L'emploi de bassines de cuisson sous vide ne s'est pas répandu au Royaume-Uni, mais certains constructeurs fournissent des bassines à confiture dites extra-rapides munies d'un élément chauffant interne en forme d'anneau, qui dans un cas présente une structure en nid d'abeilles. La cuite ordinaire est comprise entre 100 et 150 lbs (45 et 68 kg) et peut être effectuée en 5 à 6 minutes dans une bassine à cuisson rapide, tandis qu'elle demande peut-être 10 à 15 minutes dans une bassine ordinaire à double enveloppe. Le débit moyen d'une bassine à cuisson rapide serait de 3,5 tonnes par journée de 9 heures avec une pression de vapeur de 4,2 kg/cm^2. Le cuivre est le métal généralement employé pour garnir l'intérieur des bassines à confitures, mais c'est l'acier inoxydable FMB qui est le métal le plus employé dans l'ensemble de l'usine.

Quoique certaines des usines les plus petites s'adressent encore au remplissage des boîtes et bocaux à la main, cette opération est effectuée le plus souvent mécaniquement. Un type de machine qui semble utilisée à peu près généralement possède une pompe rotative centrale qui distribue la confiture aux becs de la tête de la remplisseuse. Un régulateur micrométrique pour le réglage volumétrique du remplissage permet de faire varier ce dernier sans arrêter la machine. Cet appareil peut remplir 40 à 50 boîtes d'une ou de deux livres et 15 à 20 boîtes de 7 livres par minute.

V. ENTREPOSAGE DES FRUITS

Les fruits que l'on peut utiliser en dehors de la saison sont conservés par congélation ou par l'anhydride sulfureux; mais récemment un fabricant d'emballages a mis sur le marché des tonnelets en acier vernis intérieurement et pouvant être fermés hermétiquement, dont on dit qu'ils peuvent être remplis de pulpe chaude et mis sous pression d'air stérile, pour des conservations de longue durée.

VI. DISTRIBUTION

La distribution des confitures en boîtes ne présente aucune difficulté particulière, et il n'a pas été nécessaire de modifier les méthodes employées avant la guerre.

VII. NORMES DU BRITISH MINISTRY OF FOOD (MINISTÈRE BRITANNIQUE DU RAVITAILLEMENT)

Le British Ministry of Food a institué des normes pour les confitures et les marmelades qui prescrivent les teneurs minima en fruit et les teneurs minima en résidu sec, déterminées par le réfractomètre. L'addition d'acides de fruits et de pectine à des fruits pauvres en pectine naturelle est permise. Une teneur maximum de 100 mg d'anhydride sulfureux par 100 g de produit fini est également tolérée.

VIII. FOURNISSEURS DE MACHINES

Machines à couper en quartiers et à peler les oranges ...	Robert Kellie & Son, Ltd, Dundee, Ecosse.
Dénoyauteuse	Ferrum A.G., Rapperswil, Suisse.
Pompe à air comprimé	Gresham & Craven, Ltd.
Bassines, remplisseuses, etc.	Aluminium Plant & Vessel Co, Ltd. Wm. Brierley, Collier & Hartley, Ltd. A. Johnson & Co (London), Ltd. Robert Kellie & Son, Ltd. Low & Duff, Ltd. Mather & Platt, Ltd.

XXIII. DEVELOPMENT IN SWEDEN'S CANNING INDUSTRY SINCE 1937

by F. JAKOBSEN

Director, Research Department, Platmanufaktur (Sweden)

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I. GENERAL

The development has mainly been concerned with the introduction of machines of higher speed and more automatic.

The most important points have been the changing over from hand seamers and semi-automatic seamers to automatic ones.

In 1937 a very few machines with a capacity of 60 cans/minute were the most efficient seamers used in the canning industry in Sweden. Today machines of this type are fairly common and some canners have closing machines which can work at speeds up to about 200 cans/minute.

Partly in connection with the possible use of aluminium cans and also to obtain a minimum stress on the cans during processing in general, high pressure retorts have been installed in many canneries, permitting the use of higher pressures than the pressure corresponding to a certain processing temperature during the actual process as well as during the cooling.

There has also been a general trend towards increased mechanisation as far as many other types of machines are concerned, as blanchers, cutters, peelers, etc... .

A rather extensive building program has resulted in the erection of quite a few modern, well equipped and well laid-out factories. Special consideration has generally been given to hygienic conditions and also to the welfare of the workers.

1. Research and Control

After a government sponsored investigation of the needs for research facilities in the field of food preservation the Swedish Research Institute for Food Preservation was founded.

It has started its work with a "nucleus" staff about 2 years ago (1948) in temporary quarters. It is hoped that the erection of the laboratory building will take place in near future according to plans, which have already been agreed upon.

The plans call for a staff of about 40 persons. The institute has among its other activities already started short training courses for people employed in the canning industry. Quite a few of the canning companies have also during the last years started their own laboratories for their own control and research work. Only a very few of these dates back to 1937 or earlier. The largest can manufacturer has also since 1946 a laboratory devoted to research and control work as well service work for the customers. About a year ago a compulsory quality control of canned goods for export was established working in connection with the Swedish Research Institute for Food Preservation.

2. Production

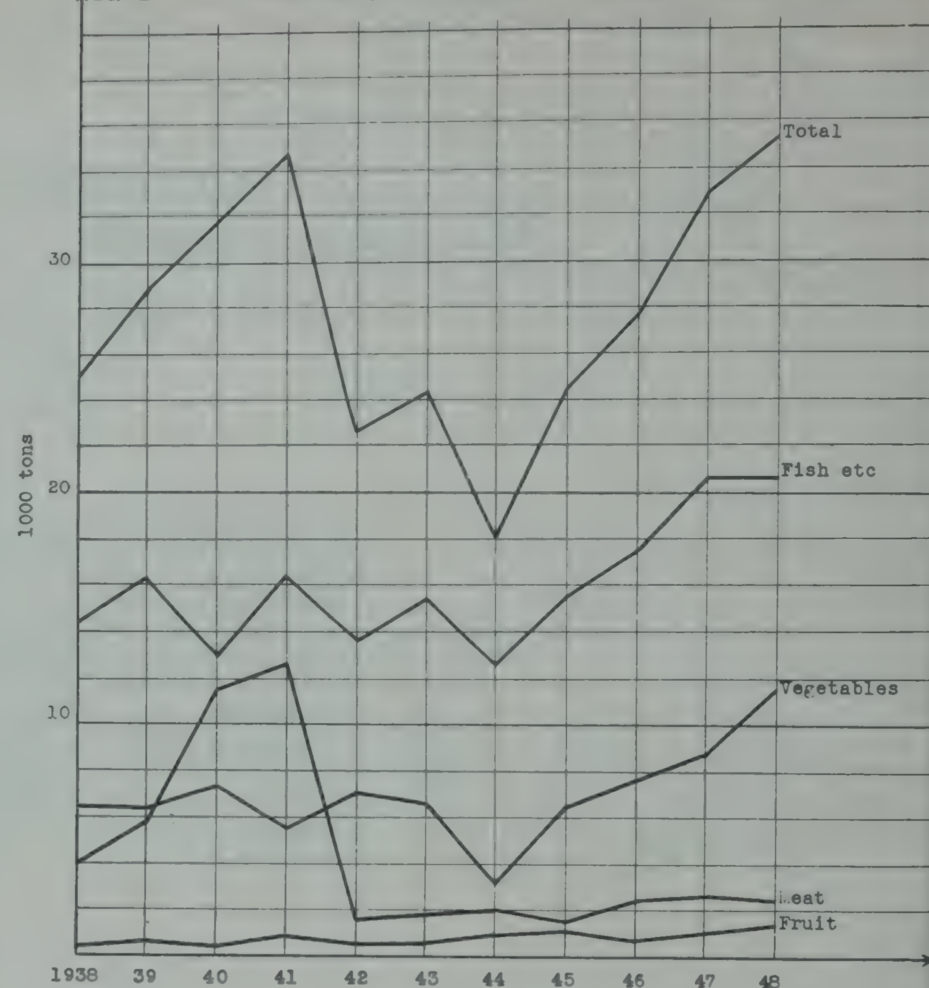
Table I gives a picture of the quantitative developments of the production of canned foods in Sweden since 1938. The statistics are at the present moment not available for 1949 and 1950, but they will very likely show the continued trend of increase in production especially of canned vegetables and probably also some increase in meat production.

The influence of World War II is very marked even if Sweden remained neutral.

The increased production of canned meat products in 1940-41 reflects both stock piling and the necessity of reducing the number of farm animals due to shortage of cattle food.

During wartime the production of canned foods was limited by the difficulties in obtaining tinplate for cans. The currency situation and the heavy demand upon the tinplate resources (the U.S. mills) in the years after the war have also undoubtedly put rather strict limits to the production volumes.

Table I.- Swedish produktion of canned foods 1938-1948



3. Containers

The production of cans was still in 1937 largely manual or semi-automatic. Only two rather slow automatic can lines were in operation in the country. This has now changed completely so that in the last years the overwhelming majority of normal food cans have been made on high-speed automatic can lines running up to above 300 cans/minute, of which however only two are in operation in Sweden today. A third one will be installed during 1951. In addition to these about half a dozen automatic lines running at lower speeds, about 150/200 cans/minute are used to some extent for production of open top cans. Even the production of deep drawn fish cans has changed materially, from handpress operations to automatic lines

During the last 3/4 years the can standards have been revised and new standards adopted securing the uniformity of dimensions, which is absolutely necessary for modern automatic production. The present standards are based upon the American and British can diameters.

The manufacture of glass jars for food canning purposes has also been modernized and most jars are now produced on high speed automatic machinery.

4. Organization

No organisation like the N.C.A. of the United States joins the canners of Sweden.

A foundation was established some years ago to obtain funds for the erection of the Institute of Food Preservation and the payment of salaries for its employees. This foundation supplies part of the money needed, and the Government pays the rest.

An association of canning technologists is at the present moment just being organized but is not yet effective.

II. DIFFERENT PRODUCTS

I. Fish

The technical developments have mainly been in connection with the machinery, the mechanical equipment of the canneries. In addition to what has already been mentioned above, automatic machines for preparing fillets herring have been introduced and also automatic machines for cutting such fillets in slices for the Swedish specialty products Herring Tid-Bits etc...

Automatic equipment for smoking sprats for the production of s.k. Sprat-Sardines has also been introduced, as well as automatic machines for the filling of cod-roe caviar into collapsible tubes etc...

To some extent herring from the fishbanks at Fladen (North Sea) has been introduced as a substitute for the normal raw material, herring caught near Iceland.

2. Meat

The technical developments have in this field been mainly the ones mentioned as general developments above.

Due to shortage of meat, and rationing, the quantities available for the canning industry have been limited and this fact has certainly been of importance also when it comes to the purely technical developments in the industry.

3. Vegetables

In this field the developments during later years have been most noticeable.

The canning lines for peas have been modernized and new factories come into operation, which utilize high-speed automatic equipment throughout. The developments have started right at the beginning with the growing of the peas, the choice of suitable varieties for canning, the harvesting, vining etc...

Several of the pea canneries are using tenderometers regularly for controlling and grading the peas for maturity. Several mixed vegetables have been marketed recently displaying beyond any doubt the effect of systematic operation and laboratory control when it comes to maintaining a high and constant level of quality.

Two types of product, which have during the last two years come to stay, and which it may be convenient to place under the heading : vegetables, are different varieties of canned soup and baby-food.

These products also show definitely, by the high and constant level of quality, the successful application of rational methods of production and quality control.

4. Fruits

The developments have not been so important in the fruit field as they have been for the vegetables.

The production of canned fruit is quantitatively at present not very big in Sweden.

The improvements have mainly taken place in the manufacture of jams, marmalade and juices. This development is not shown in Table I.

Modern equipment has been introduced however in quite a few plants making the last mentioned products. One may mention the use of vacuum pans, of continuous operation equipment, high speed closing machines for jars and bottles etc...

XXIV. THE CANNING INDUSTRY IN TUNISIA

by R. HAMARD

Sous-Directeur Etablissements J. J. Carnaud et Forges de Basse-Indre (Tunisia)

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I. INTRODUCTION

Up to a few years ago the food canning industry only had a very small place in the economy of Tunisia, and its development dates from about 1939 the year when the Regency found it necessary, because of its isolation, to turn towards the canning industry.

Before this period the usual method of food preservation was by drying but the Tunisian industrialists encouraged by the Administration quickly realised that it would be necessary to work in a more rational manner. Some altered their factories, others built new ones, and they are now in a position to produce canned foods by modern methods.

II. FRUITS AND VEGETABLES

The drying of these on an industrial scale still exists and Tunisia has about ten drying factories with a total capacity of ten to fifteen tons of fresh material per day. In addition, preparation of fruits and vegetables has not been forgotten and at the present time five plants capable of cleaning fruit and vegetables exist throughout the whole length of Tunisia : at Tunis, Sousse, Sfax and Tozeur.

As regards canned foods nearly 100 plants are interested in preserving products by heat sterilisation. Some handle jam, others equipped with vacuum concentrators handle tomato products, and three are equipped for producing fruit juices by flash pasteurisation.

Since fruit and vegetables are only cultivated in the North of Tunisia most of these plants are situated in this part of the country.

From 1946 to 1950 the following production is reported :

Products	1946 (kg)	1947 (kg)	1948 (kg)	1949 (kg)	1950 (kg)
Jam	1,270,000	1,757,000	1,055,000	290,000	333,262
Fruits in Syrup	-	32,549	29,925	60,000	431,753
Fruit Juices	-	-	726,761(a)	158,225(a)	147,776(a)
Concentrated Fruit Juices	-	6,912	22,403	27,000	1,816
Tomato Products	850,000	559,000	1,100,000	1,200,000	136,157
Peeled Tomatoes	-	-	-	-	111,921
Canned Artichokes	-	233,000	767,363	87,000	168,117
Various Canned Vegetables	150,000	1,073,027	606,973	425,000	215,915
Arissa	-	-	-	-	167,970

(a) litres

The reduction in the quantity of jam produced is explained by the fact that local consumption decreased more and more as other foodstuffs became more available. Fruits in syrup, tomato products and artichokes particularly (although the quantities packed up till now are small) must be considered as the products of the future.

In fact since the plants for cleaning fruit and vegetables have no more than 100 cubic metres capacity, it is certain that the development of plans for irrigation, the planting of more and more fruit trees (particularly apricots), the interest shown in the growing of muscatel raisins, the introduction of the canning of sweet pimentos in oil (arissa) the production of which reached in 1950 to about 200 tons shows that a few years hence the Tunisian food canning industry will attain a renewed activity in the packing of fruits and vegetables.

III. FISH

Apart from canned fruit and vegetables the industry has also turned towards the handling of fish products and about 30 factories are now in existance for this purpose. Somewhat primitive workhops handle pelamid fishes in the region of the Gulf of Cabes and salt the surplus from the anchovy fishing in the region of Tabarka, but fourteen factories at the present time produce canned sardines or sardinella, and three others are equipped to handle tunny. The former are in the region of Sousse and Mahdia, and the latter are situated in Tunis (two) and at the tip of Cap Bon where there is a tunny fishing vessel.

Since 1946 the tonnages of fish and lobsters produced have been the following :

Products	1946	1947	1948	1949	1950
	(kg)	(kg)	(kg)	(kg)	(kg)
Canned Fish in Oil					
Sardines-Sardinella	611,000	610,000	1,744,400	3,300,000	2,768,467
Tunny	48,700	34,700	29,500	20,000	153,087
Pelamides	100,000	53,000	120,000	62,000	87,042
Canned Fish in Tomato					
Sardinella	12,000	16,000	467,000	73,000	
Canned Fish in White Wine and in Spices	422,000	233,481	97,570	34,000	31,969
Canned Fish in Vinegar	11,613	20,858	21,380	-	-
Canned Fish in Brine	2,000	550	-	-	-
Salted Fish	344,822	66,766	-	-	-
Lobsters and Shrimps	-	-	-	3,200	-

If the production of canned fish in white wine and in pickle has decreased, the tonnage of blue fish packed shown a marked increase, which leads one to suppose that, with increased means of fishing particularly, the production will get bigger and bigger.

The first trials this year to catch tunny with a seine net have proved that tunisian waters are particularly rich in pelamids and an increase in the production of this canned fish should surely develop very shortly.

The plant actually existing in Tunisia will enable any surplus production of both fruit and vegetables as well as fishery products to be absorbed.

It is certain, however, that the increase in importance of the export market (in 1938 Tunisia imported 1,000 tons of canned fish, whereas in 1950 she exported nearly 3,000 tons), will force the canners to improve their equipment.

This, however, is far from being out of date and in most of the newly constructed factories they have all the latest improvements.

One can, in fact, say that at the present time the food canning industry in Tunisia is based on the latest and most modern machinery. Moreover, rational methods of manufacture guide the canners and first class articles can be produced, either in the packing and cleaning, the drying or the canning industry.

I. Cleaning and Packing

The treatments given are designed to prolong the life of the products without changing their original

characteristics and consist of a series of operations which the large factories existing in the country are capable of carrying out. These are :

1. sorting;
2. grading;
3. disinfestation;
4. brushing;
5. disinfection in hermetically sealed tanks in which the product is subjected to the action of the following :
   a) vacuum to burst any insect eggs;
   b) toxic gas to kill them;
   c) a second vacuum to eliminate all trace of gas;
6. packing.

Since Tunisia produces on the average 37,000 tons annually of Deglet Nour or Degla dates, which are the most suitable for export, it should be noted here that most factories which pack these fruits complete the various operations listed above, either by humidifying or by a partial drying.

2. Drying

The Tunisian industry uses for the drying of fruit and vegetables either continuous equipment or batch equipment of the "Japiot" type. The latter enables the temperature and humidity to be varied during the operation. Drying is carried out according to data supplied by the authorities who have laid down the limits for moisture in dry products as follows :

1) 10 % for most green vegetables;

2) 15/20 % generally for fruit.

They also insist on the storage of goods after their manufacture and before packing in hermetically sealed containers to protect them from air and parasites.

This method of food preservation was much used in Tunisia during the war, but it should be noted that numerous difficulties were encountered particularly in rehumidifying the products. Probably because of too severe treatment during drying, a thin impervious skin formed apparently due to coagulation of albuminoid material which prevented the products from being completely rehydrated. It is partly for this reason that the results obtained were not what had been expected. Moreover, the public very much prefer heat sterilised canned foods and this is the method of preservation which is most used.

3. Canning

It is in the packing of the product in the cans that the greatest improvements have been seen in the last few years, since most canneries have been put up during that time. The canneries generally now have modern plant, steam jacketed pans, stainless steel equipment, conveyor belts, automatic seamers, etc..

The canner closely checks his manufacture and often submits his products to laboratory control, and the Government also supervises it and the Tunisian Standardisation Office (OTUS) checks the quality of goods for export.

These various controls give excellent results. For tomatoes, for example, certain varieties are used, some amongst them retaining better after processing their original colour. Juice extraction is carried out in stainless steel automatic extractors and the product is de-aerated before being flash pasteurised.

These successive operations allow Tunisia to produce tomato juice of the first quality, and similar results are obtained with many other products often following on the correct use of French methods.

It should be noted, however, that the tunisian canner may find himself up against new problems, as is the case for blue fish where a technique quite different from that used in France is generally employed.

Since the sardinella which are caught in tunisian waters have a very delicate skin and do not stand up to frying, there results a poor appearance which may detract from the reputation of the canned product. It is thus necessary to find another meth d of cooking and it would appear that by using the Portuguese method for the cooking of sardines Tunisia has found the solution of the problem. The fish is cooked in steam and this technique, far from being a disadvantage, has shown on the contrary, a product which has a much better appearance and is much more digestible. In this case it seems, therefore, that the difficulties which had arisen at the beginning were in the end useful because they permitted the improvement of a product which at first seemed likely to be inferior to French canned sardines.

In conclusion, the constant building of new factories, the numerous commercial outlets which are appearing, the increasing quantities which are produced, the care given by the canners to equip themselves with modern plant, and the continuous attentions paid by the Administration only to allow the exportation of first quality goods leads us to envisage in a short time many new possibilities for Tunisian canned foods.

XXV. RECENT TECHNICAL DEVELOPMENTS IN THE CANNING INDUSTRY OF THE UNION OF SOUTH AFRICA

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I. INTRODUCTORY

The canning industry in the Union is, with the exception of one or two products, of recent growth; indeed many packs were first produced during the period covered by this report. In these circumstances there has been, as one would expect, a general tendency to use the methods and machinery developed in countries where canning has a longer history, the more so as there are very few canned foods produced in the Union which are peculiar to that country. For these reasons there are no procedures or apparatus representing real novelties to be reported.

Twelve years ago the total output of the canneries in the Union was about 55 million pounds weight; the total annual production is now around five times that figure. The changes and technical developments which have accompanied this very considerable increase in the output of what is, in the main, a recently established industry, form the subject matter of this report. As already indicated, it concerns methods and apparatus already known.

The products canned in the Union include fish, fruit, vegetables and meat; it will be convenient to discuss these separately.

II. FISH CANNING

Fish canning factories have been established on the West coast of the Union of South Africa for over twenty five years, but until 1940 only the crustacean Jasus lalandii, variously known as South Africa Rock Lobster, Crawfish or Langouste du Cap, was canned in any appreciable quantity. There have been few changes in this section of the industry in the period under review for two reasons : firstly, the quantity packed has not been and cannot be substantially increased owing to the limit placed on catching by the Division of Fisheries and by uncertain weather conditions tending to restrict inshore fishing. Secondly, the canning of crustacean meat does not lend itself to the introduction of mechanical methods of handling and packing. With regard to improvements in quality, the recently established Fishing Industry Research Institute has recommended some changes in canning procedure aimed at obtaining packs of more uniform quality : for example, the intensity of the Maillard-type reaction which is responsible for the browning of rock lobster during processing has been reduced by the introduction of a through triple sea - water washing of the flesh, the object of which is to leach out the fermentable reducing sugars. The effect of processing temperatures on the intensity of browning, and its relationship to the times necessary to ensure a safe pack, have also received detailed study, both at the Fishing Industry Research Institute and elsewhere.

Work as yet unpublished has established a relationship between the concentration of reducing sugar in rock lobster and the intensity of browning produced during processing. Except in grossly over-processed packs, the intensity of the brown colour developed is more closely related to reducing sugar concentration than to the processing time and temperature.

The major development in the fish canning industry, however, has been in the production of canned pilchards, which has risen from two or three hundred thousand pounds weight in 1939 to over twenty one million pounds in 1950. In the initial stages of this expansion fish were prepared and packed into cans by hand, but a number of canneries have been re - equipped or newly erected to can pilchards with automatic handling and packing equipment. Vacuum pumps are used to elevate the fish from the boats, after which they are descaled and flumed to the factory, where they are held above the canning lines in bins containing salt water. Provision for chilling this sea-water is made in some canneries. The fish pass to nobbing and gutting machines of American manufacture which incorporate the vacuum-evisceration principle; these work in conjunction with the automatic can packers on the 1 lb. (301 x 411) size but for the 1 lb. oval can, which has been introduced to the Union since the war, hand packing is still used. Nobbing and gutting machines of Norwegian manufacture are used by some canners, especially in canning lines set up for packing oval cans. Pilchards are given a thermal exhaust of up to 30 minutes at 210°F; for packs to which tomato sauce is added the cans are,

in most canneries, drained, after which the sauce is introduced. The general consensus of opinion is that draining improves tomato sauce packs, since the puree retains more of its colour and heaviness. Processing times are similar to those used in California, e.g. 75 to 90 minutes at 240°F for A_1T cans.

Pilchards canning is carried on in conjunction with fish meal reduction plants, to which all cannery waste is sent 20,000 tons of fish meal were produced last year in the St. Helena Bay area alone. The possibilities of over-fishing are being watched by the Division of Fisheries, but little or no diminution has yet been noted in the enormous shoals which appear each year off the West coast of the Union and South West Africa.

Apart from Rock Lobster and Pilchards, experimental work has been conducted at the Fishing Industry Research Institute on a number of less important packs of canned fish, which amount in the aggregate to about 9,000,000 lbs. per annum. Among these may be mentioned the green Abalone (Haliotis midae) which has been canned on a small scale; the flesh is dry-salted for 24 hours, desalted in lukewarm water and packed in added water. A new method of canning Snoek (Thyrsites atun), has also been tried successfully; the fish is prepared in a manner similar to that used for Tuna, by precooking whole fish for 1 1/2-2 hours at 240°F, allowing them to cool, removing skin, bones and brown flesh, and packing the white meat into cans with added oil. The long precook is required to soften the bones, which otherwise prevent the fish being cleanly divided by the blades of the fish cutter.

III. FRUIT CANNING

The canning of fruit has been established for many years in the winter rainfall area of the Cape Province, where considerable quantities of deciduous fruit are grown, but in the last decade the quantity has risen from about 27 3/4 million pounds weight to over 78 million pounds. Peaches, pears and apricots account for about 40 % of the annual pack.

Concurrently with the expansion in production there has been a general tendency to reduce labour requirements by using peach pitters and pear-peelers, while lye-peeling has become popular with peach canners continuous cooker-coolers are now in common use.

However, the most important progress has been made in the production of new varieties of fruit, especially peaches, the aim having been not only to improve their canning qualities, but to produce earlier and later-ripening varieties. This work, conducted by the Western Province Research Station, Stellenbosch, has culminated in the production of peach varieties which ripen up to 46 days before and after the Kakamas peach, which is the main canning variety in the Union. Other work is being conducted on berry fruits and guavas, with a view to improving their canning characteristics.

Deciduous fruit accounts for about 88 % of the Union's canned fruit pack, but the other 12 %, made up to miscellaneous packs, each in themselves comparatively small, includes two products deserving particular notice-pineapple and granadilla.

Since 1945 there has been a noteworthy expansion of pineapple canning, particularly in the Eastern Province, where large areas are being planted to pineapple for canning purposes. In the design and equipment of the canneries where this fruit is being handled, full use has been made of American equipment and methods. At the present time both Queen and Smooth Cayenne varieties are being canned. The Queen produces during the life of the plant an average of 6 tons per acre, although in certain areas this yield is very much lower. The Smooth Cayenne may yield up to 25 tons per acre during the plant life, but a reasonable average figure would be 15 tons; apart from its higher yield, the Cayenne has the advantage of being less wasteful, as it has shollower "eyes" than the Queen, of which about 60% is wasted, whereas wastage in the Cayenne is around 45%. The problem of wastage in relation to costs is resulting in plans for the recovery of sugar, citric acid and molasses from trimmings.

The granadilla is grown on a large scale in the Northern Transvaal, where what is believed to be the world's largest granadilla farm is situated. A small quantity of this crop is canned as whole pulp with seeds included, in which form it is used as a flavouring for fruit salads, but since the juice finds its greatest use as a beverage, investigations have been made into the methods by which this may be canned. The sweetened unconcentrated juice may be preserved by simple pasteurizing, and makes a drink whose qualities should be better known. For bottled beverage manufacture, however, the juice has hitherto been chemically preserved and put down in barrels, but the possibilities of vacuum-concentration have recently been investigated. Work in this country has shown that the amylopectin of granadilla causes such thickening of concentrated juice that the concentrate is difficult to handle; the high acid and low pH of the juice reduces the activity of the amylolytic enzymes, but a commercially available enzyme has been found that will degrade the amylopectin, and juice treated with this enzyme produces a relarively free-flowing product even at four-fold concentration. This concentrate, however, has as yet been produced on a pilot scale only, and it is possible that centrifugal separation of the starch may be found more suitable for commercial operations. The loss of starch would, it is believed, improve the appearance of bottled granadilla beverages, as it tends to form an unatractive greyish deposit, especially in carbonated products.

A brief reference to the problem of hydrogen swells as it affects Union canners might be made at this point. For Union canners in general, and fruit canners in particular, it is especially desirable to obtain high average vacua in their products, for quite apart from the extra shelf life conferred on canned fruits by a high vacuum, canners at the coast have to contend with the fact that when packs are railed to the big inland market of the Johannesburg area, where the altitude is around 6,000 feet, cans lose, in effect, about 6 inches of vacuum. The time taken for canned fruit to become domed at these altitudes is therefore appreciably shorter than at the coast. The reduced atmospheric pressure on the high weld is sometimes responsible for goods canned at sea level with a low average vacuum appearing blown and unsaleable on reaching these elevated areas.

Within the next few months tin-plate will be produced in the Union at a cold reduction strip mill now nearing completion. It is hoped that this plant will make the tin-plate supply position somewhat easier, and, by using steel of low phosphorus content, produce a tin-plate with low hydrogen evolution properties.

IV. VEGETABLES

In the ten years covered by this report the production of canned vegetables has risen from about 4 million to over 50 million pounds weight per annum. As in the case of other product groups, the technical developments which have accompanied this very considerable expansion have followed lines of canning practice in Europe and America, and there are no novel procedures to report.

On the fresh vegetables canned in the Union, peas are by far the most important single pack, amounting to over half of the total. The vining of peas has recently found favour with the larger canners; size grading has become common practice; but the separation of over-mature peas by procedures involving brine flotation has not been very successful. The use of viners has accentuated two difficulties : one, the elimination of the Devil's Thorn (Tribulus terrestris), might be regarded as an agricultural question, but until this weed is eliminated canners will continue to seek a method of removing these troublesome green seed capsules from the peas. Among the methods tried, with only limited success, are felt and wool rollers designed to pick up the seeds as the peas pass on a conveyor belt beneath, and a shaker with a felt pad, which arrests the seeds while allowing the peas to move forwards.

The second problem which vining has accentuated is that of flat - sour spoilage; it is well known that the degree of soil contamination—and hence the infection with flat - sour spores also—is much greater on vined peas than on hand - picked peas. Heavy losses have been suffered within the last year by canners who, through insufficient water supply or inadequate spray washing systems, have been unable sufficiently to reduce the load of spores on the peas prior to canning. Flat - sour spoilage is a real difficulty in the Union, where temperatures are high enough to favour the growth of thermophilic spores.

Another development in vegetable canning has been the production of high - solids tomato paste , of which considerable quantities were imported from Europe. Stimulated by import control and the demands of the fish canners, vacuum evaporators of the barometric leg type have been erected which now supply the internal demand for tomato paste, with an increasing quantity available for export.

Cream - style sweet corn canned in the Union is produced by American methods, using huskers, corn-cutters, silkers, batch-mixers and consistency controllers - equipment already sufficiently well known and described.

Corn starch of guaranteed low thermophilic spore content is already available to canners; it is hoped that a canner's grade of sugar will be available soon, in view of the thermophilic spoilage to which this product can give rise in vegetable packs.

The standards for thermophilic spores which the canner's grade corn starch meets, and within which it is hoped the canner's grade sugar will fall, are rather more stringent than those of the U.S. National Canners Association, particularly in the case of non-H_2S producing thermophilic anaerobes, although the method of testing is essentially the same. The inocula, however, are first autoclaved for 30 minutes at 230°F. In order to eliminate spores of low heat-resistance. The following standards then apply :

- flat-sour spores per 10 gm .... not more than 10;
- thermophilic anaerobes not producing H_2S per 10 gm .... no tubes positive out of 6, or if one tube is positive, no positives in a duplicate set of 6 tubes;
- Thermophilic anaerobes producing H_2S per 10 gm .... not more than 5.

V. MEAT

Meat canning in the Union is a small but growing industry based almost entirely on Pork, since the available beef supplies are usually insufficient to satisfy the fresh meat trade. Apart from canned sausages which need not be discussed here, the two most important packs are ham and sliced bacon. Both these products present difficulties to the canner because the processes needed in this country to make the pack microbiologically stable generally cause some rendering of fat, friability on cutting, and other signs of over-cooking : the pasteurizing type of processing apparently used successfully in Europe for similar products, cannot be relied upon in the Union, where ambient temperatures are higher. Microbiological stability naturally varies with the type of cure the ham receives and the skill with which it is handled during preparation, but generally speaking some degree of pressure processing is required. The commonest type of spoilage is that due to aerogenic sporing aerobes which exhibit maximum activity between 25°C and 37°C.

Canned sliced bacon is, in the main, processed to sterility; raw vacuum-packed and pasteurized packs are unreliable from the microbiological stand-point.

Quality standards have been drawn up and published by the South African Bureau of Standards for a number of canned meat and other products; these may be voluntarily accepted by Union canners whose product, if approved, is permitted to carry the South African Bureau of Standards Mark on payment of a fee. Thereafter the Bureau maintains an inspection of the approved product and the factory itself, for which certain structural and hygienic requirements are laid down. In all cases the Specifications of the Bureau of Standards over the quality of raw materials, drained weight, (where applicable), fill of container and freedom from defects and foreign substances; in compounded products such as sausages, soups and so forth, the composition of the final product is also stipulated. In addition the products bearing the Bureau Mark have to meet microbiological requirements based on the incubations and culture of a fixed proportion of each day's production.

XXVI. FOOD LAWS AND ENFORCEMENT IN THE UNITED STATES

by C. H. BLOEDORN,

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The principal food laws of the United States are those of each of the forty - eight states and the laws of the Federal Government. Jurisdiction under the many current laws is determined in accordance with the source or legal authority under which the law was passed. State jurisdiction is limited to state boundary lines. On the other hand federal jurisdiction exists only within a state when the merchandise in question is imported, is to be exported, or is destined to or has passed from one state to another. Augmenting jurisdictional factors which tend to complicate enforcement and compliance efforts is the fact that a considerable variation in content is to be found among the food laws of the various forty-eight states. The trend, however, is for much needed uniformity. At the present time approximately fifty percent of the states have adopted food and drug laws patterned after the federal law. To foster simplified compliance and enforcement more states will undoubtedly follow since the Federal Food, Drug and Cosmetic Act is generally accepted as a basically good law which may well serve as the corner stone for all food, drug and cosmetic regulatory action in the United States. For that reason the comments to follow will largely relate to that law.

Consumer protection is the basic purpose of the Federal Food, Drug and Cosmetic Act of June, 1938. Throughout its various sections the fact is self-evident. Self-evident also is the benefit derived by the manufacturers. Resultant high quality levels and the confidence with which the public purchases its foods, drugs and cosmetics demonstrate the fact. In addition to being the legal order of the land, the Act - to most manufacturers - serves as the pattern on which manufacturing practices are based. In commenting on the Act one authority (+) expressed its purpose in the following manner : " What this law essentially does, with respect to such products is to outlaw any that are harmful, to prohibit their misrepresentation, and to place their sale on an informative basis ".

Consumer protection was also the intent of the original Pure Food & Drug law of 1906. At that time it represented a great step forward in food and drug regulatory legislation. Through the years, however, many deficiencies were brought to light. It became evident that its scope had to be extended and various phases of the law strengthened to assure the protection for which it was intended. Particularly pertinent was the general feeling that the law must be framed so as to more adequately cope with problems of consumer health. As a result, the need for a new or revised law became evident long before efforts to pass such a law began in 1933. Notwithstanding, five years of debate, revision, and compromise were needed before the new law was enacted in June of 1938. Various branches of the Federal Government, several industrial associations, and several consumer associations all were very actively instrumental in formulating the new law. It stands today, therefore, as a regulatory instrument representative of the best effort of all affected segments of the U.S. population.

The Act is administered by a federal organization known as the Food and Drug Administration. It, in turn, forms a part of the Federal Security Agency, which division of the Government is charged with a great many functions relating to the public health and welfare. Other federal laws such as those relating to false advertisement of foods, drugs, and cosmetics, and special laws relating to various agricultural products, all tend to supplement the Federal Food, Drug and Cosmetic Act.

A section-for-section commentary on the provisions of the Act itself is not indicated in a report of this type since copies of the Act are available from the Federal Security Agency in Washington, D.C. Further, although the Act is extremely broad in scope, it is written in very direct and understandable language. The basic philosophy of the Act and a clearer concept of its operational procedure presently appear to be subjects of greater interest. Hence, the comments to follow are to be generally limited thereto. For clarity and simplicity, we shall also limit ourselves to the treatment under the Act of foods only, rather than foods, drugs, cosmetics and devices.

Fundamentally the Act provides for regulatory action on the part of its administrative body to assure the consuming public that any food merchandised through interstate channels shall not be adulterated or misbranded. It defines what is meant by adulteration and by misbranding using language which is specific where need be and general where possible. It does not include specific regulatory limits and tolerances. To have done so would have dated the Act and made it long, cumbersome, and static without flexibility to accommodate itself to new conditions. It is fortunate therefore that the authority to set up working tolerances has been delegated and is not a specific part of the Act. For example, Section 402 of the Act relates to the conditions under which "A food shall be deemed to be adulterated - (a) (1) If it bears or contains any poisonous or deleterious substance which may render it injurious to health ....." The words "any poisonous or deleterious substance which may render it injurious to health" are significant in that they emphasize the point in question. Note that the Act does nor state how much of any poisonous or deleterious substance would be considered injurious. That phase is left to the regulatory body whose function it is to establish proper limits in the light of present day knowledge and in the light of court decisions.

On the other hand, Section 402 further states that "A food shall be deemed to be adulterated - (3)

(+) The Food, Drug and Cosmetic Act in the United States - C.W. DUNN- Food, Drug & Cosmetic Law Quarterly September 1948, p.308.

if it consists in whole or in part of any filthy, putrid, or decomposed substance, or if it is otherwise unfit for food ...." In this instance there is no compromise with filthy, putrid, or decomposed substances. That somewhere a decision as to working tolerances must be made, however, has been recognized by the U.S. courts. Hence, for all practical purposes the Act forbids filthy, putrid, or decomposed substances and the Food and Drug Administration with the guidance of the courts determines the degree of perfection it is possible to achieve using good manufacturing practices. As an example consider tomatoes for canning. It is hardly a contestable fact that where mold exists on or in the tomato some degree of decomposition is concurrently present. On that basis the degree of mold found in a sample is considered a proper indication of the degree of decomposition which was present in the raw material. It became the function of the Food and Drug Administration to establish a mold count tolerance on which the acceptability of tomato products could be judged. The first mold count tolerance for tomato juice was set at 50% positive fields in 1931. Good commercial practice at that time could produce a product within the tolerance limit, bad practice did not. Five years later in 1936, the tolerance was lowered to 35 % positive fields. In 1938 it was lowered to 25 % and then down to 15% in 1940. Tolerance changes simply reflected improvement in preparation technique and handling methods. When such improvements were, in the opinion of the Food and Drug Administration, available and commercially feasible to food producers who had a genuine interest in improving quality the "Food and Drug" lowered the limit accordingly. Today the mold count working tolerance for tomato juice is 20% positive fields having been raised from 15 % as the result of work done by industry which establised that it was not commercially practicable to operate on the basis of 15 % positive fields. A remarkable degree of flexibility is shown. At the same time, under the terms of the Act it is entirely possible to effect seizure on the basis of the food having been prepared under insanitary conditions. Proof that the food itself contains filthy, decomposed, or putrid substances is not necessarily required.

That the Act has all manner of consumer protection as its foremost objective is obvious. At the same time it is the consensus among F & D officials and also of the great majority of sincere manufacturers that in the final analysis consumer interests and manufacturer interests are identical. Under the stress provoked by seizure action or the sting of an adverse court decision occasional doubt may develop but fundamentally the identical nature of the interests served by the Act remains unchanged.

As already indicated the Federal Food, Drug and Cosmetic Act concerns itself with adulteration of food and also the misbranding of foods. Unfortunately the law governing false advertising of foods is a separate Act and is administered by an agency other than the Food and Drug Administration. Consolidation of these functions is indicated and under consideration.

An additional and important portion of the Federal Food, Drug and Cosmetic Act is embodied in that portion (Section 401) which instructs the administrative agency to prepare and promulgate for all classes of foods (with some listed exceptions) "a reasonable definition and standard of identity, a reasonable standard of quality, and/or reasonable standards of fill of container when such action will promote honesty and fair dealing in the interest of the consumer". In effect, Section 401 of the Act establishes the condition under which all foods excepting fresh and dried fruits, fresh and dried vegetables, and butter (+) ultimately may be defined by law as to identity, quality, and fill of container. Inasmuch as the procedure set up for writing such standards calls for a very thorough study of all phases of the product and involves industry and consumer hearings etc.., it will probably be many years before all of the common foods are so defined. At the present time definitions, standards of identity, and/or standard of fill of container, have been promulgated for a great many products including wheat flour, milk and cream, oleomargarine, and the canned products peas, tomatoes, peaches, apricots, pears, cherries, jams, jellies, shrimp and oyster, to mention a few.

It is obvious from even a brief review of the Act and its provisions that the administrating body, which is the Food and Drug Administration, must be an agency of technical experts. It is their duty to interpret the general terms of the Act and also to perform its regulatory functions. The U.S.F. & D. is one of the oldest regulatory groups of the U.S. Government having evolved from the Bureau of Chemistry, which agency was originally chosen to administer the first comprehensive food and drug law in 1906. If the Act has been a successful instrument in maintaining food quality and protecting the public health, it is - without question - due in very high degree to the excellence of its administrative group.

The Food and Drug Administration must maintain a very comprehensive organization in order to perform the duties assigned to it by the Act. Briefly, the organization consists of the Washington D.C. offices and laboratories which are divided into eleven functional divisions included in which are the Division of Antibiotics, Division of Food, Division of Microbiology, Division of Program Research and so on. In these offices and laboratories are developed the scientific information, the new methods of analyses and identification, toxicity data and other instruments used in regulatory and enforcement work. Additionally there are sixteen strategically located district offices and laboratories. These are primarily for the purpose of inspection of manufacturers and the development of inspection data on official samples from interstate or imported shipments. Approximately one thousand persons are so employed at an annual cost of slightly in excess of four million dollars, or, in terms closer to the individual the cost amounts to approximately three cents per U.S. citizen per year.

The Annual Report of the Food and Drug Administration for 1948 lists its actions on foods for that year and from these listings a tabulation has been prepared which amply demonstrates the scope of food enforcement activities. Since "fines" and "jail sentences" are listed, the table also provides an insight into the futility of continued violation of the Act. Actions on drugs, devices, special dietary products, and cosmetics are not included. For foods alone 933 seizures were made during 1948. Penalties inflicted by the courts amounted to 71 fines of $ 1000.00 or more, and no less than 9 jail sentences for violations.

The Federal Food, Drug and Cosmetic Act is not a single edged instrument wielded by a civil service group whose word and action cannot be questionned. The Act does give to producers certain rights which effectively check any tendency toward overzealousness on the part of the enforcement agency. At the same time, it provides almost unlimited opportunity for the enforcement agency to obtain its information and develop its facts. An outline of more or less usual enforcement procedure under the law as applied to canned foods might be of interest.

The Act provides for entry by accredited Food and Drug inspectors for purposes of inspection into any factory, warehouse, or establishment in which food is manufactured, processed, packed, or held for introduction into interstate commerce. Further, the Act also provides that shippers, transport companies and

(+) Exceptions to these are avocados, cantaloupes, citrus fruits, and melons.

ll carriers engaged in interstate commerce shall permit " access to and to copy all records showing the movement in interstate commerce of any food, ... ". In addition to these very broad authorities granted to assist the Food and Drug in locating illegal shipments, state and city food officials cooperate and the public itself has learned to report violations and ask that they be investigated.

Product	Number Seizures	Criminal Prosecutions Instituted	Injunction Petitions	Fines of $1000.00 or more	Jail Sentences	Import Shipments Denied Entry
Beverages and Beverages Materials ...	37	12	-	9	1	623
Bakery Products	39	76	2	7	2	48
Cereals and Grain Products and Feeds.	73	73	4	10	1	39
Chocolate and Sugar Products	90	31	-	5	-	561
Dairy Products	141	49	3	10	1	29
Eggs and Egg Products	27	9	-	3	2	10
Flavors, Spices, Condiments	37	6	1	-	-	1,361
Fruits and Fruit Products	138	20	-	9	-	649
Macaroni and Noodle Products	16	14	2	7	-	43
Meat Products and Poultry	10	2	-	-	-	20
Nut and Nut Products	52	7	-	2	1	292
Oils and Fats	14	4	-	-	1	43
Sea Food	74	13	1	2	-	765
Vegetables and Vegetable Products ...	185	20	1	7	-	302
TOTALS	933	336	14	71	9	4,785

If, after locating a shipment, an investigation for possible violation is indicated, the Food and Drug inspector is authorized to do so at Government expense. He must, however, draw sufficient samples to provide a duplicate set to the owner of the shipment on demand except under circumstances, as listed by regulation, which cause such additional samples to be unnecessary or unreasonable. Examination is conducted by Food and Drug technicians and their findings constitute the basis for future action. If, in the opinion of the Food and Drug officials, seizure is warranted then condemnation proceedings are begun resulting in the seizure of the goods by the United States court. At this point or sooner, under Section 302 of the Act, the Food and Drug on showing sufficient cause, may ask the U.S. courts for an injunction to restrain further violations. If granted the person or company so enjoined is effectively prevented from operating interstate until the conditions in violation of the Act are corrected.

When a seizure is made the person who has possession of the goods is officially advised of the seizure. Ownership is then established. The owner, under reasonable circumstances previously mentioned, may examine official samples and in any event has the right to contest the Government allegations in a federal court of law. Trial by jury is the prerogative of the defendent. When the seizure is contested, it then becomes mandatory that the Food and Drug Administration establish a violation of the Act if the defendent is to be judged guilty. Preponderance of evidence in a so-called seizure or civil case is considered sufficient proof. If decision is reached not to contest the government allegations it is then possible in some types of violations to bring the goods into compliance under the supervision of the Food and Drug Administration, otherwise, the seized lot is suitably disposed or destroyed by court order.

Whether criminal proceedings are in order largely depends upon the character of the alleged violation, the intent, and to some extent, whether the occasion is a first offense. If the Food and Drug Administration believes criminal proceedings are indicated, it is obligated under the Act - and before such action is taken - to so advise the person or persons responsible for the violation and provide for a private and informal discussion for presentation of such person's views. Depending upon the facts a decision is then reached as to whether criminal prosecution will be instituted. When instituted the defendent may plead guilty or not guilty as he chooses. In the event of a not guilty plea the burden of proof rests on the Food and Drug Administration and its evidence must prove the guilt of the defendent beyond a reasonable doubt.

The possible penalty for a violation of any single provision of the Act is imprisonment for not more than one year or a fine of $1000.00 or both. However, where intent to defraud or mislead is established the penalty is stepped up and may become imprisonment for not more than three years or a fine of not more than $ 10,000.00 or both for each provision of the Act violated. Actually most violations of the Federal Food, Drug and Cosmetic Act simply result in the loss of the goods or reconditioning to bring them into compliance. Where more severe action is indicated, however, the record shows the courts are not unmindful of the penalties incorporated into the Act.

Imported food shipments must comply with the Federal Food, Drug and Cosmetic Act in the same manner as domestically produced foods. The operational procedure of the Food and Drug Administration differs somewhat, however. When a shipment arrives at a port of entry notice of the shipment providing opportunity to obtain samples is forwarded to the Food and Drug Administration by the customs office in charge. Admission of the shipment is then based, insofar as the Act is concerned, on whether the product complies in all respects. In the event the samples show evidence of violation, the owner or consignee of the shipment is so notified. "Such notice shall allege the respects in which such article appears to be adulterated, misbranded, or otherwise subject to the provisions of the Act, and shall set a time and place for such owner or consignee to appear and introduce testimony". -- Reg. 1.307a. After the hearing the owner or consignee is again noti-

fied as to whether the shipment may enter the country. If admission is denied the notice states the reas or reasons for denial. The owner or consignee then has three months in which to export, destroy, or reco dition the goods. All expenses pertaining to a shipment which is refused entry are chargeable to the own or consignee and in default constitute a lien on any future importations. The Food and Drug Administr tion actions on import shipments are final and are not subject to court review as is the case with domest shipments.

Finally, the Act also provides for regulatory action on foods packed in the United States and de tined for export to a foreign country. Such foods must be in accord with the specifications of the forei purchaser, must not be in conflict with the law of the country to which it is being exported and must identified by outside label as being for export. It is possible, therefore, to receive in foreign countri foods packed in the United States which do not meet the stringent requirements of the Federal Food, Drug a Cosmetic Act. Whether this be considered unfortunate or otherwise is largely based on point of view, but t fact remains that under the provisions of the Act the same standards of quality to which the Act is point are possible and become mandatory for export shipments as soon as the recipient country chooses to enact law of similar scope and requirement. For export shipments under the Act, therefore, the law of the recipie country is the determining factor.

XXVII. SOME COMPARISONS BEETWEN THE FOOD LEGISLATION OF VARIOUS COUNTRIES

by C. L. HINTON

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I. INTRODUCTION

I must commence this paper by disclaiming any intention of making comparisons in any invidious sense between the food legislations of different countries by suggesting that some legislation is better than other. A study of the widely varying ways in which this legislations has emerged and has operated makes it evident how this depends on the general legislative, social and economic background which is so specific for each country. Indeed, with the known characteristics of a people it could often not be imagined that the development of this legislation could have taken any very different course from that which it has in fact taken. It is remarkable, when one cares to look into it, how very little direct copying from one country to another seems to have occurred in food legislation, even as between countries where one might have imagined that requirements would be very similar and where therefore much trouble might have been saved for the later entrants to the field.

II. THE CHARACTER OF FOOD LEGISLATION IN ITS HISTORICAL DEVELOPMENT

In countries where food legislation began early it appears to have arisen as a result of the focussing of attention on a particular kind of malpractice. In the U.K. for instance, the gross adulteration of coffee and tea led to laws dealing with these products in the early part of the eighteenth century. In France, the emphasis from early in the nineteenth century appears to have been on misdescription or counterfeiting of the legitimate distinguishing mark of a product (i.e., manufacturer's name or locality of origin), which is readily understandable in a country where the distinctiveness and character of food and agricultural products is so closely linked with brand names. In Russia, as early as 1832, a beginning was made with public health aspects, and in addition to an injunction against the sale of spoiled and unfit foodstuffs, the use of harmful colouring matters or of harmful metallic receptacles in the preparation or storage of foods and beverages was prohibited. Denmark, in 1843, was possibly the first country to particularize on the subject of colouring matters and to introduce a list of permitted harmless colours for use in the colouring of foods; at that time, of course, these colours were all natural vegetable or mineral substances.

At a later date also, it is interesting to notice, there has sometimes been found a necessity for directing legislative attention to particular foods even while a general food law has been in process of formulation. One instance of this is the special pre-occupation in the U.S.A. with the hygienic control and quality of meat products, arising from the alarm spread among the American public in 1906 by the publication of Upton Sinclair's remarkable book "The Jungle". This special interest resulted in the passing of a Meat Inspection Act at about the same time that the first U.S. Food and Drugs Act was passed to deal with food in general.

In what might be called the second era of food legislation the approach to a more general law against adulteration came in many countries in the form of clauses or passages in the Penal Code. Such references ranged from admonitions against fraud and the precise prohibition of any addition, mixture or adulteration or the use of harmful substances and materials, as in the Penal Code of the Old Austrian Empire (1852); down to the admirably terse clauses of the Penal Code of Cuba (1879), which merit quotation : "The following will always be subject to confiscation.... 2. Beverages and foodstuffs falsified, adulterated, or spoiled, being

harmful...... 4. Foodstuffs which defraud the public in quantity or quality.....". Quite naturally, these Penal Codes were strongly concerned with penalties, and the Gilbertian threat of the Austrian code is worth recalling from the past for possible use in the present : " The duration of the penalty and its augmentation are to be fixed according to the amount, the slyness, malignity, danger resulting from the deed, and the extent of confidence thereby betrayed ".

The third era of legislation came with the emergence of general (or basic) laws prohibiting deception and adulteration and (a fundamental step) providing usually for inspection, sampling, and testing. The Food and Drugs Act of the United Kingdom led the way, in 1875, and was followed before the end of the century by the general food laws of Germany (1879), Italy (1890), Belgium (1890), the Austrian Empire (1896), and of some British dependencies (St. Christopher, 1887; Barbados, 1889). In the early nineteen-hundreds the peak of this phase of development was reached, with the laws of Portugal (1902), Bulgaria (1904), France (1905), Switzerland (1905), the U.S.A. (1906), Jamaica (1908), Spain (1908), New South Wales (1908), New Zealand (1908), Ceylon (1914), Cuba (1914), and possibly other countries. Since the first world war the promulgation of these basic laws has continued, for example in Trinidad (1917), Tunisia (1919), the Dominican Republic (1919), The Netherlands (1919), Victoria (1919), Canada (1920), Honduras (1920), Brazil (1923), Mexico (1926), South Africa (1929), Norway (1933), and other countries.

Many of these basic food laws, while embodying provisions against adulteration, fraud, misdescription, harmfulness to health, etc..., provided no criteria by which the nature, genuineness, and purity of particular foods could be appraised. This left the way open not only for varying interpretation by food control authorities, but also often for evasion because of the reluctance of the authorities to take action in the absence of precise legal standards of composition and purity for many foods.

For foods already subject to special regulations in which presumptive standards of genuineness had been established (notably for milk and milk products), this difficulty did not of course apply, and in fact much of the control activity was focussed on such products. For other foods not so standardised, and subject only to the basic law, the difficulty was partly solved, as in the U.K. and some other countries, by the slow accumulation of case decisions which served to provide standards of a sort. Formulation of standards by this process was hap-hazard, cumbersome and sometimes ill-informed; though it might be held that it avoided the expenditure of effort in formulating standards where no genuine need for them had arisen. Nevertheless, in course of time, the need for extending the area of legal standards became more and more felt.

Basic food laws often gave powers to the ministries or departments concerned to make regulations for individual foods or classes of foods under the umbrella of the basic law. Foremost in this field were the Australian States, New Zealand (1924), Venezuela (1921), Brazil (1923), Switzerland (1926), Italy (1926), Canada (1928), and South Africa (1930). It must be admitted that these attempts as rushing the position often suffered from a lack of sufficient precision and of full appreciation of technical questions involved. This has necessarily tended to allow of a certain amount of arbitrary interpretation in applying the standards.

A more wary approach has been made in other countries, by taking one food or class of food at a time and defining composition, criteria of purity, etc... with sufficient adequacy to leave much less scope for uncertainty of interpretation; and also making sufficient allowance, by inquiry, consultation of affected interests, and so on, for technical matters involved in the production of the food. This extended procedure in development of standards has been followed notably by France, Belgium, the Netherlands, Norway and Germany, and now more recently by the U.S.A. and the U.K. Broadly included in all these regulatory approaches to the standardisation of foods, it should be said, is also the standardisation or control of practices such as the addition of colouring matters and preservatives and of the use of metallic and other substances in the handling or packing of foods.

It must not be imagined that countries having no basic food law and regulations under it have no effective means of controlling the purity and wholesomeness of foods. Usually a variety of separate enactments and decrees fulfil the purpose of hygienic control of particular kinds of foods, or of requirements of purity and harmlessness in certain directions, such as liability to contamination from plant, ustensils and containers. Examples of such systems are afforded by Sweden and Argentina. In the former country, the control of foods in respect to metallic contamination, preservatives, and colouring matters is, in fact, with somewhat ruthless realism, merged in the Poisons Act.

III. THE CHANGING EMPHASIS IN SUBJECT MATTER OF FOOD LEGISLATION

The foregoing brief survey has dealt with the stages in the character of legislative machinery as it has developed up to the present. It will be of interest to consider the changing emphasis of the subject matter of this legislative machinery. Three main phases can be discerned, with of course a considerable degree of overlap. The first two may be regarded as dealing with aspects of what may be termed "macro" quality. Some of the earliest legislative activity was instigated by and directed against gross and often harmful adulteration, such as the addition of weighting or foreign substances to tea and coffee, the addition of alum to bread, the use of poisonous mineral substances in colouring confectionery and other foods, mineral adulteration of flour and milk, adulteration of pepper with ground olive stones, and so on.

The next phase may be considered to be the law's concern with the major debasement of composition and quality, not necessarily resulting in harmful effects on health, but often involving deception or fraud, especially when accompanied by incorrect description. This concern found expression in the major attack on adulteration as consisting of the addition of substances to, or the abstraction of ingredients from, foods so as to prejudice the purchaser in respect of harmfulness or, to quote the phrase used in the British Food and Drugs Act, in respect of "the nature, substance or quality" of the food. Usually the basic food law, or a sanitary or penal code, has supplied the initial attack in this phase, but has required to be supplemented by case decisions or by the setting up of standards of composition, as already mentioned, and of regulations for prescribed forms of description and labelling. Associated with this phase, too, is the insistence on veterinary inspection and certification of meat, both for direct consumption and for use in manufactured meat products, which in many countries has been a prominent legal requirement for many years.

There is no doubt that there has been a considerable improvement in the minimum level of quality of foods as a result of this kind of legislative activity. This improvement in macro-quality however, has resulted in a gradual refinement of legislative interest, which is now, in its third phase, becoming more and more concerned with "micro"-quality. This term is intented to embrace the quality of the food as effected by the presence of added materials such as colouring matters and preservatives, of metallic contaminants, of the newer additive and residual chemical substances, and of hygienic purity and bacterial safety. Legislative interest in such a question as the use of colouring matters in foods, it is true, goes back a long way (Russia, 1832; Denmark, 1843), but is now tending to shift in emphasis from the nature of the colouring matters themselves to the degree of purity which is desirable in them when they are used in foods. Illustrative of this new emphasis is the certification of purity now called for in the U.S. and Canadian regulations on coal-tar colours for foods. So, too, the attitude to possible harmful metallic contamination, which began (as often referred to in the basic food laws) with an interest in rather crude forms of contamination from the addition of metallic compounds or from the use of poisonous metals in contact with foods, has now tended to shift to the minute traces of harmful metallic contaminants which gain inadvertent entry into foods unless special precautions are taken. Apart form the general requirements for the hygienic purity and handling of foods which are usually embodied in basic food laws or regulations, attempts have been made in some countries to formulate precise stipulations on this score, as with mould count in tomato products, and the limits set up for the content of bacteria and other micro-organisms in such foods as milk, cream, gelatine, tomato products, ice cream and other frozen foods, and so on. As for the most recent aspect of this phase, the question of control of chemical additions, and residuals from insecticides, etc... used in the growing, and preparation of foods, legislation is still in the making. Possible harmfulness to health is of course the prime consideration. The problems involved are considerable, as shown by the inquiries and discussions which have been taking place especially in the U.S.A., and will call for skilful legislative handling. Meantime there is much to be said for simplicity of statement, and a pertinent clause in the law of Venezuela as long ago as 1921 may be called to mind : " In order that a substance be considered harmful to health, and consequently not be permitted to be added to foodstuffs even in minute quantities, it is sufficient that science entertain doubts as to its harmlessness, whether or not the effects be immediate or slow" - the significant word here being the word "science".

IV. THE LACK OF UNIFORMITY IN FOOD LEGISLATION

As was shown earlier in this paper, different countries have trod the path of legislative enterprise in foods by very different routes, and in very varying tempo. However, different countries, from national habit in diet or from special interest in the production of particular foods, have placed varying emphasis on the importance of legislative control of different foods. All this, combined with nationalist sentiment no doubt, has resulted in an almost complete lack of co-ordination in different legislations which, in the present era of interplay in world trade, has become irksome and in many ways quite stultifying.

One may perhaps be forgiven for quoting examples of some of these anomalies. Thus the six Australian States have separate systems of food regulations which, while superficially very similar, yet differ in materially important detail - as for instance in having slightly different lists of permitted colouring matters. The need for this, in a total population of some 8 millions, is elusive. Again, taking the South American countries, their systems of food regulations shown no co-ordination whatever. For example, none of them has chosen to adopt the same list of permitted coal-tar colours as its neighbours; one of them, in fact, has preferred to come to France for its adopted list.

The confusion in the requirements of different countries for the tomato solids content of tomato paste and concentrates will be familiar to those present. Other anomalies in regulations for tomato products may be less well- known. Thus the limits for the Howard count for moulds in the two adjacent countries of Argentina and Brazil are 50% and 65%. Limits for bacterial count have been laid down by Canada and Brazil, the one at 100 millions, the other at 200 millions, per c.c. In the U.S.A. and Canada, the addition of calcium salts to canned tomato is permitted up to a limit of 0,026%; but in New South Wales calcium chloride may be added to a limit of 0,064 % of total calcium, which includes the natural calcium of the tomato, leaving a permissible addition of about 0,05 % of calcium.

V. THE POSSIBILITIES OF SOME MEASURE OF INTERNATIONAL AGREEMENT IN FOOD LEGISLATION

In considering the possibility of international efforts to co-ordinate food legislation so as to remove some of the anomalies and multiplication of standards, the subject must be divided into two parts. In the first place, there is no doubt that a large number of standards for foods have been formulated to correspond with the traditional and prevailing tastes and habits of the country concerned. It is quite obvious that it would be impossible to achieve agreement in any attempt to secure international uniformity in such standards. Nor, equally obviously, would it be desirable; every country is entitled to its own special ideas about its food.

On the other hand, where the character of the food is not involved, but only questions of universal applicability, there would seem to be the possibility of a large measure of co-ordination. In the field of contamination with undesirable substances, for instance, there can be no question of individual national idiosyncrasies. Limits of tolerance for the amounts of such contaminants as harmful metals, insecticidal residuals, and so on, should be capable of being fixed on the basis of ascertainable scientific fact, which is universal. There is no reason, then, why there should not be agreement on these limits. The same may be said, with less immediate likelihood of success, of an attempt to secure uniformity in regard to a range of colouring matters which would be generally acceptable. The list need not be unduly restricted. Over 70 coal-tar colours are already included in the lists of different countries, and there has been no evidence that any of these countries has been in any way prejudiced in health by reason of the particular colours on its

list. Preservatives, too, might well become the subject of agreement, at least in regard to the limits permitted in different foods. Sulphurous acid and benzoic acid and their salts are almost everywhere recognised and accepted as harmless preservatives for particular purposes, but there is no uniformity as to the limits within which they may be used. It should not be difficult to reach such agreement.

VI. CONCLUSION

In this brief survey I have had time to deal only with the general aspects of the subject and have not attempted to make any detailed comparisons. Indeed, if this were to be done, it could only be achieved by means of a systematic breakdown into the separate aspects of the subject, whether legal, administrative, nutritional, hygienic, etc.., and a comparative study of the mode of control of the main types of foodstuffs in the various countries. This would obviously be a very considerable undertaking, and I make no apology for the fact that I have not been able to do more than give a merely introductory outline for others to fill in. There are other very important matters which I have not touched upon at all, such as the question of analytical control, of weights and measures and their tolerances, and of guarantee, and I mention these now in conclusion so that at least it can be said that I have brought them to your notice.

XXVIII. COMPARISON OF THE COST AND AVAILABILITY OF CANNED AND FRESH FOODS

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I. INTRODUCTION

When preparing meals, housewives usually have the choice between fresh foods, and foods preserved by the Appert process, by quick-freezing or by dehydration.

Their choice is determined in particular, by their purchasing power, by prices, qualities and by the facilities available for obtaining, using and keeping the desired products.

Great consideration also must be given to nutritional value, safety and, consequently, reputation.

The comparative study we have made is based on the prices charged in large stores for canned foods, factory-made jams and quick-frozen foods of well known brands and of good quality. These prices are practically those recommended by the manufacturers for the retail sale of preserved foods produced in 1950.

The cost of the corresponding foods prepared directly in the home with fresh products bought from retailers has been worked out for the various seasons on the basis of minimum and maximum sale prices.

As regards fruit and vegetables, the prices were those noted by the competent officials of the Ministry of Economic Affairs, in 1950, in a large food store and at a Brussels market.

It must be noted that in many parts of the country fruit and vegetable prices are usually higher than those charged in Brussels and in the other large cities.

For home preparations we have taken account not only of the price of raw material, but also of waste, additional ingredients and fuel consumption.

As the prices of raw materials vary at a given date according to qualities and other factors, we have established price graphs.

The A curves are based on the monthly average of the lowest daily prices charged at the places mentioned. The B curves are based on the average of the highest prices.

As many housewives have to use outside help, we have drawn up other curves (A' and B') which include the cost of labour, on the basis of the hourly wage paid to a charwoman, i. e. Frs 15.- per hour.

Our prices for household preparations are in most cases lower than the actual ones, as we only took account of factors of general and unquestionable significance. Our calculation, in fact, does not include purchasing costs (time and transportation) or the time spent in supervising cooking, cleaning household utensils, jars, etc....

However, we considered that in many homes these costs may amount to Frs 8.50 per kilo of consumable produce and we showed this cost, on each graph, by a vertical arrow starting from the B' curve. It is obvious

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(+) The Institut National pour l'Amélioration des Conserves de Légumes (National Institute for the Improvement of Preserved Vegetables) is subsidised by the Institut pour l'Encouragement de la Recherche scientifique dans l'Industrie et l'Agriculture (Institute for Encouraging Scientific Research in Industry and Agriculture).

that these costs vary according to the quantities of food prepared, the products, the seasons, the possibilities of obtaining supplies and the household organisation.

We must reming the reader that fresh foods always lead to waste, which is sometimes considerable. Unless a refrigerator is available, which is seldom the case in Belgium, they are apt to spoil quickly.

Moreover, it frequently happens that too large a quantity of a given dish is prepared, with the result that part of it is fed to animals or thrown away.

Also of importance is the fact that in many households the use of canned foods, if accompanied by other methods of simplifying housekeeping problems, allows of using a daily help instead of a whole-time servant, or even of doing without domestic help altogether.

Simplification of household work also increases the possibility of exercising a lucrative occupation. Of course, everything depends on national customs, but the example of America fully confirms our views and general improvement in the standard of living of a country unquestionably leads to the use of industrially processed foods.

II. GENERAL CONSIDERATIONS

For the purpose of facilitating comparisons we have worked out the prices per kilo of consumable food, i.e. strained off if necessary.

Cooking by gas was the method chosen and it was considered that 10 minutes were needed to bring a litre of water to the boil, with a gas feed of 500 litres/hour, and that a flame consuming 200 litres of gas per hour was required to keep the same quantity of water boiling. Cost of gas : Frs 3.30 per cubic metre.

Sugar has been reckoned at Frs 14.- per kilo and salt at Frs 2.50 per kilo.

For certain ingredients of secondary importance we were notable to obtain monthly price schedules; we therefore based our calculations on the prices charged by a large store in June 1951.

We believe it necessary to point out that our services were not in possession of the indispensable data for drawing up this report and that the various official and professional bodies we consulted could only supply incomplete statistics for many products.

Two or three years' preparation would be required to draw up a report giving rise to no criticism.

Out-of-season prices, which are usually very high for fruit and vegetables, were not always taken into consideration by the organizations which drew up the statistics; therefore in many cases the diagrams of household costs only cover a few months of the year.

The comparison of the respective cost of fresh and preserved foods is shown on the graphs. The purchasing periods, in months, are shown is abscissae and the prices in ordinates.

We find that the cost of a diet composed of sterilized canned foods, and even of quick-frozen fruit and vegetables, is not substantially higher than that composed of fresh products, purchased in season, and especially, that outside of the months of horticultural production, preserved foods are those which are the less expensive. It is certainly possible, even in midwinter, to prepare very economical meals without using preserved fruit and vegetables, but the resulting diet is frugal, monotonous and of very questionable nutritive value.

In establishing our graphs we have taken the price of preserved vegetables of the highest quality, although most second quality preserved foods can compare very favourably, as to quality, with a great number of home preparations.

Although second quality canned foods are very cheap, they are in only slight demand, from which it may be concluded that in the field of preserved produce, the Belgian public gives the first place to quality.

It is to be noted that in the case of many products, only first quality preserved goods are manufactured; therefore, the factories only buy raw materials of unquestionable quality.

Even when two qualities exist, often as a main brand and a sub-brand, inspection is very strict and we have seen, for instance, threshed peas rejected although their sole defect was that they were too ripe.

Cost at factory of sub-brands of preserved vegetables, in percentages of the price of main brand products.

	4/4 Can	I/2 Can		4/4 Can	I/2 Can
Extra-small peas	78.8	79.9	New carrots	75.6	77.3
Small peas	78.4	79.9	Peas and carrots	79.9	81.3
Standard peas	77.8	80.0	Mixed vegetables	-	77.9
Stringless beans	77.5	79.5	Salsify	73.5	75.0

As regards fish and meat, it is difficult to compare the fresh products with the preserved products, as the latter are more of the nature of specialities which it is hardly possible to prepare in the home. Calculation of cost, however, shows that here again the sterilized foods are practically no more expensive than the equivalent household preparations.

We did not personally compare the cost of fresh fish with that of quick-frozen fish.

According to the information given us by the one and only Belgian factory for the quick-freezing

of fish, which was established quite recently, the price of quick-frozen, entirely edible fish, during Lent of 1951, was lower than the cost of the edible portion of fresh fish. At present, in view of the fact that at this period of the year there is a seasonal fall in the price of fresh fish while that of quick-frozen fish remains stable, the latter is slightly more expensive, at least in the large provision stores in Brussels, for in the suburbs the frozen product is still the cheaper.

As regards possibilities of use, it is obvious that stabilized products simplify the housewife's work to a great extent; we shall therefore only consider availabilities of supplies.

Canned foods, factory-made jams and other preparations which are stable at normal temperature, are on sale in a large number of shops, many of which deliver to the home or ship to the provinces. These provisions are, therefore, very easily procurable and we consider that their distribution can hardly be improved from the consumer's standpoint.

In Belgium, most fresh fruit and vegetables become scarce and expensive after the home-growing season. They then are difficult to procure outside of the large cities, where, moreover, they are only sold in a few specialised stores.

Preserved foods then play an important part towards bettering the Belgian people's diet.

It is easy to get an idea of present facilities for obtaining foodstuffs by examining the attached tables I, II and III (pp. 15 and 16). It should be noted also that preserved foods are on sale in most food stores, including groceries, green-groceries, fruiterers', butcher's shops, etc.., whereas perishable fresh produce are the object of a more limited trade, the greater part of which is carried on in the markets.

Consequently, the consumption of preserved foods in Belgium is not restricted by purchasing difficulties, or in most cases by objective price considerations; the main factors worthy of attention are "reputation", "confidence and habits". Sooner or later the truth becomes known, but it depends on the action of preserved food manufacturers whether or not in the near future public opinion concurs with the unanimous opinion of specialists, in particular that expressed by Sir William SAVAGE in a long article entitled "Canned foods in relation to health", published in "The Lancet", the British medical journal, in 1939 (Nov.4).

Among other things, Sir William SAVAGE writes :

" Considering the whole of the data, I think it is obvious that, as a source of food-poisoning, canned " foods at the present time are definitely safer than ordinary foods. They are protected foods and much " more protected than ordinary foods from the risk of causing food poisoning.

" On the nutritive side, canned foods compare favourably with fresh foods, when allowance is made for " the fact that the former are already prepared for use and the latter are subjected to any losses which may " take place in domestic preparation and cooking. These facts apply qualitatively as well as quantitatively.

" As regards our food supply generally, canned foods can be accepted as a safe and convenient source and " one without any special hazards, nutritional, chemical, or bacterial."

As far as quick-frozen foods are concerned, we must admit that their distribution network is still limited and reduced to large cities.

Although we have no precise data we may say that these products, which have only recently appeared on the Belgian market, are at present far more difficult to obtain than other preserved foods and fresh products. However, the distribution network will expand and we see the future position as follows :

A great part of the fish which is now consumed in the fresh state will be replaced by quick-frozen fish. The latter will shortly become as conveniently procurable as fresh fish is at the present time. It is even likely that fish will gain ground thanks to quick-freezing and that the distribution network of frozen products will become more extensive than that of fresh fish.

In the field of fruit and vegetables, quick-freezing will not gain any spectacular victory and fresh vegetables will only be partly replaced by frozen products, although the latter are of excellent quality, easy to prepare and very economical (see the graphs herein). In Belgium, quick-frozen fruit and vegetables, like canned products, are more especially consumed during the winter and that is the season when it is essential to develop purchasing and storing facilities. In our opinion, therefore, an increase in consumption of quick-frozen fruit and vegetables depends to a great extent on the development of the distribution network and on the increased number of households in possession of a refrigerator, enabling them to keep the frozen products at home; this is interesting especially for consumers who live at some distance from the shops.

It is to be observed that consumers who have become accustomed to quick-frozen fish continue to buy it even when they can easily obtain fresh fish and at times when fresh fish is less expensive.

Many housewives do likewise as regards frozen fruit and vegetables, even in the summer.

For many people, in fact, convenience and quality are the determining factors.

We have been enabled to make this study thanks to the assistance given us by the Ministry for Economic Affairs and Middle Classes, the Institut National des Statistiques, the Union Fédérale du Commerce et de l'Alimentation, the Inter-professional Associations of Food Canners, manufacturers and dealers, to all of which we express our deep gratitude. We also owe special thanks to Mesdemoiselles JOLLY and MASSIN, of the State School of Domestic Science and Agriculture in Argenteuil who informed us concerning household preparations an to Mr. J. SIMON, engineer of Inacol, who gave us most active assistance.

III. COMPARISON OF COSTS

The comparisons we have made are given in the following tables.

1. EXTRA SMALL PEAS

Price of preserved products (Belgian francs)

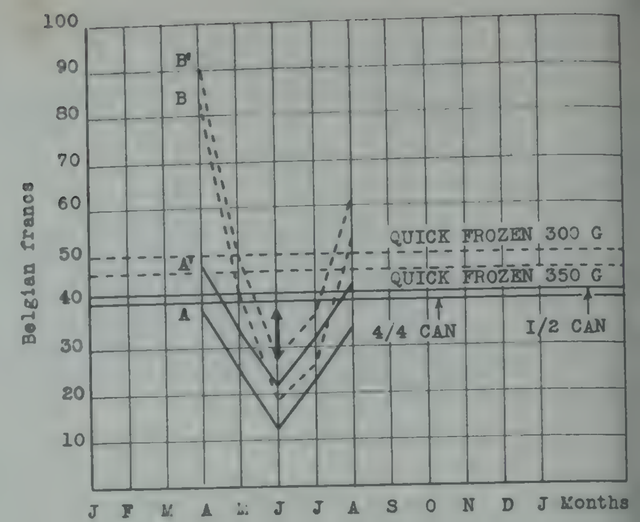
Method of preservation	Size of can	Weight of edible portion	Price	Price per kg of edible portion
Canning	1/2	290 g	12.25	42.25
"	4/4	580 g	23.00	39.65
Quick-freezing		300 g	15.00	50.00
"		350 g	16.75	47.85

Cost to housewife (Belgian francs)

Waste .... : 58 %
Shelling 1 kg of peas : 15 minutes
Cooking .... : 15 minutes with 10 g of sugar and 7 g of salt for 1 kg of peas in pods.

Cost .... : $\frac{100}{42}$ (Price + $\underset{\text{sugar}}{0.14}$ + $\underset{\text{salt}}{0.01}$) + 0.45 + ($\frac{100}{42}$ x $\underset{\text{labour}}{3.75}$)

N.B. : This household cost concerns non-screened peas; therefore, the same curve is used for comparison with the price of the various sizes of canned and quick-frozen peas.



2. SMALL PEAS

Price of preserved products (Belgian francs)

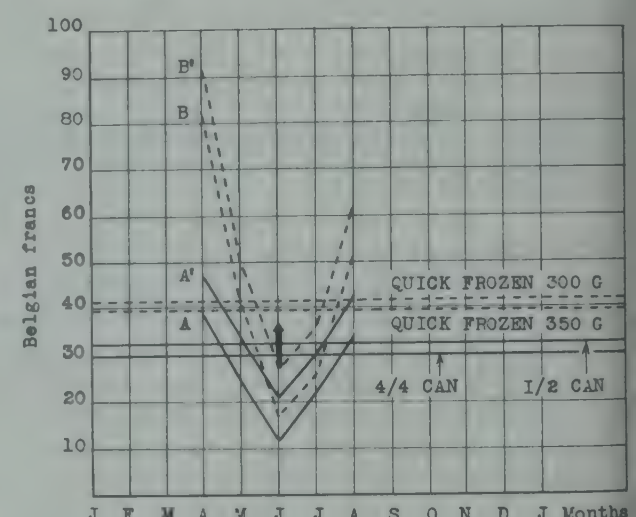
Method of preservation	Size of can	Weight of edible portion	Price	Price per kg of edible portion
Canning	1/2	290 g	9.50	32.75
"	4/4	580 g	17.50	30.17
Quick-freezing		300 g	12.50	41.66
"		350 g	14.00	40.00

Cost to housewife (Belgian francs)

Waste .... : 58 %
Shelling 1 kg of peas : 15 minutes
Cooking .... : 15 minutes with 10 g of sugar and 7 g of salt for 1 kg of peas in pods.

Cost .... : $\frac{100}{42}$ (Price + $\underset{\text{sugar}}{0.14}$ + $\underset{\text{salt}}{0.01}$) + $\underset{\text{gas}}{0.45}$ + ($\frac{100}{42}$ x $\underset{\text{labour}}{3.75}$)

N.B. : This household cost concerns non-screened peas; therefore, the same curve is used for comparison with the price of the various sizes of canned and quick-frozen peas.



3. MEDIUM PEAS

Price of preserved products (Belgian francs)

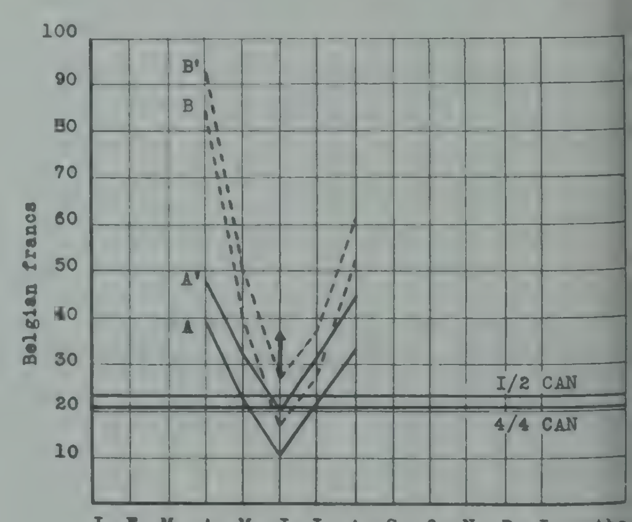
Method of preservation	Size of can	Weight of edible portion	Price	Price per kg of edible portion
Canning	1/2	290 g	6.90	23.79
"	4/4	580 g	12.50	21.55

Cost to housewife (Belgian francs)

Waste .... : 58 %
Shelling 1 kg of peas : 15 minutes
Cooking .... : 15 minutes with 10 g of sugar and 7 g of salt for 1 kg of peas in pods.

Cost .... : $\frac{100}{42}$ (Price + $\underset{\text{sugar}}{0.14}$ + $\underset{\text{salt}}{0.01}$) + $\underset{\text{gas}}{0.45}$ + ($\frac{100}{42}$ x $\underset{\text{labour}}{3.75}$)

N.B. : This household cost concerns non-screened peas; therefore, the same curve is used for comparison with the price of the various sizes of canned and quick-frozen peas.



4. STRINGLESS BEANS

Price of preserved products (Belgian francs)

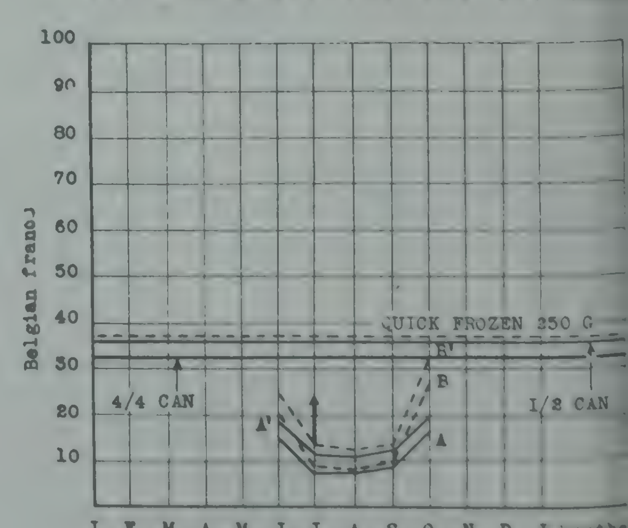
Method of preservation	Size of can	Weight of edible portion	Price	Price per kg of edible portion
Canning	1/2	240 g	8.50	35.40
"	4/4	500 g	16.00	32.00
Quick-freezing		250 g	9.00	36.00

Cost to housewife (Belgian francs)

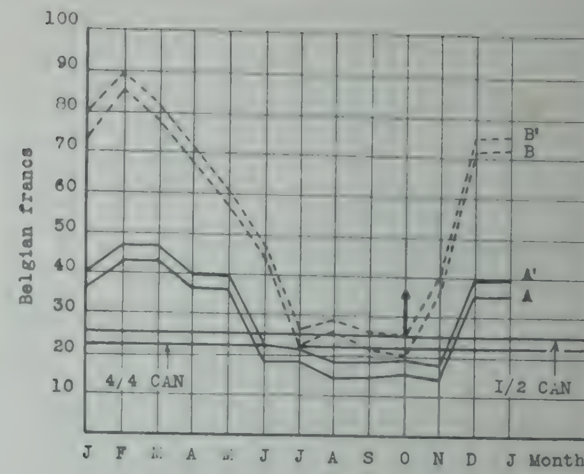
Waste .... : 8 %
Preparation .... : 15 minutes
Cooking .... : 30 minutes with 10 g of salt.

Cost .... : $\frac{100}{92}$ (Price + $\underset{\text{salt}}{0.03}$) + $\underset{\text{gas}}{0.62}$ + ($\frac{100}{92}$ x $\underset{\text{labour}}{3.75}$)

It should be noted that prices paid the grower in 1950 were extremely low. See Horticulture Index figures, p. 14.



5. CUT CELERY



Price of canned products (Belgian francs)

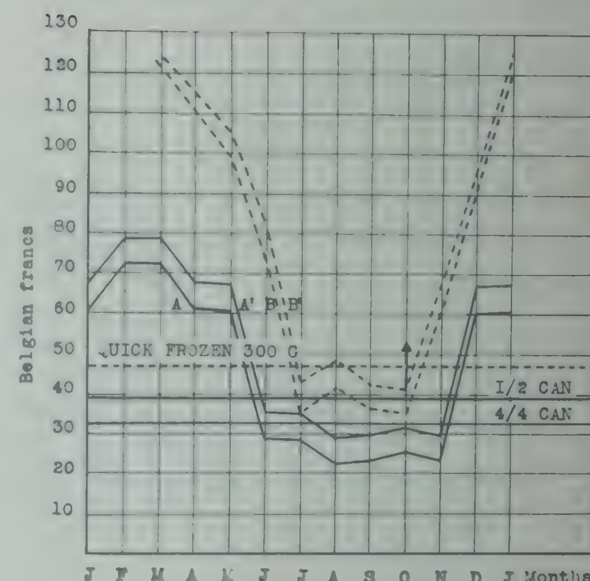
Method of preservation	Size of cans	Weight of edible portion	Price	Price per kg of edible portion
Canning	1/2	300 g	7.50	25.00
"	4/4	600 g	13.75	22.91

Cost to housewife (Belgian francs)

Waste : 30 %
Preparation : 10 minutes
Cooking : 30 minutes with 20 g of salt

Cost : $\frac{100}{70}$ (Price + 0.05) + 0.65 + ($\frac{100}{70}$ x 2.5)
sel gas labour

6. CELERY STALKS



Price of canned products (Belgian francs)

Method of preservation	Size of cans	Weight of edible portion	Price	Price per kg of edible portion
Canning	1/2	310 g	12.25	39.51
"	4/4	650 g	22.00	33.84
Quick-freezing		300 g	14.00	46.66

Cost to housewife (Belgian francs)

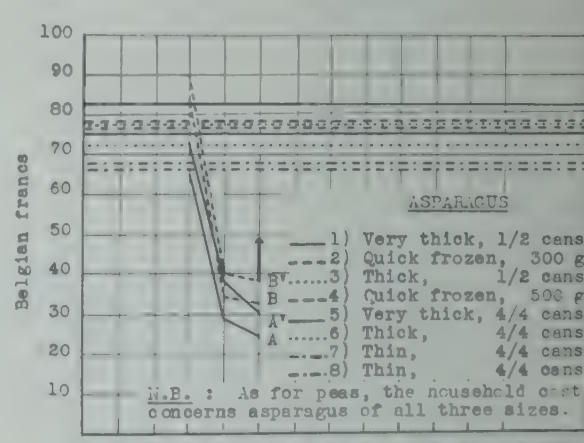
Waste : 60 %
Preparation : 10 minutes
Cooking : 30 minutes with 20 g of salt.

Cost : $\frac{100}{40}$ (Price + 0.05) + 0.65 − 3 + ($\frac{100}{40}$ x 2.5)
salt gas (1) labour

N.B. (1) - The quantity of celery recouperable for soup-making is estimated arbitrarily at Frs 3 per kg or fresh celery.

7. ASPARAGUS STALKS

7. ASPARAGUS STALKS



Price of preserved products (Belgian francs)

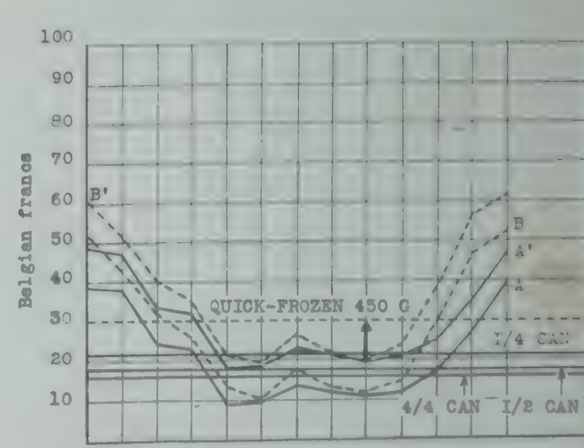
Quality	Size of cans	Weight of edible portion	Price	Price per kg of edible portion
Very thick	1/2	280 g	23.00	82.14
" "	4/4	575 g	43.25	75.21
Thick	1/2	280 g	21.50	76.80
"	4/4	575 g	41.50	72.17
Thin	1/2	280 g	18.75	66.96
"	4/4	575 g	39.00	67.82
Quick-frozen		500 g	38.00	76.00
" "		350 g	27.00	77.14

Cost to housewife (Belgian francs)

Waste : 40 % Preparation : 15 minutes per kg
Cooking : 20 minutes with 10 g of salt.

Cost : $\frac{100}{60}$ (Price + 0.03) + 0.55 + ($\frac{100}{60}$ x 2.75)
salt gas labour

8. SIEVED SPINACH



Price of preserved products (Belgian francs)

Method of preservation	Size of cans	Weight of edible portion	Price	Price per kg of edible portion
Canning	1/4	190 g	4.00	21.05
"	1/2	400 g	7.25	18.12
"	4/4	840 g	13.50	16.07
Quick-freezing		450 g	13.50	30.00

Cost to housewife (Belgian francs)

To prepare the equivalent of 1 kg of canned sieved spinach, taking into account waste and reduction in cooking, 1.7 kg is needed on an average (2 kg at the beginning of the season and 1.5 kg at the end).

Preparation of one kg of fresh spinach : 15 minutes
Cooking " " " " " " : 3 minutes, with 5 g of salt.
Chopping " " " " " " : 5 minutes.

Cost : 1.7 x (Price + 0.012 + 0.32) + (1.7 x 5)
salt gas labour

9. SALSIFY

Price of preserved products (Belgian francs)

Method of preservation	Size of cans	Weight of edible portion	Price	Price per kg of edible portion
Canning	1/2	250 g	13.00	52.00
"	4/4	500 g	23.75	47.50
Quick-freezing		300 g	14.50	48.33

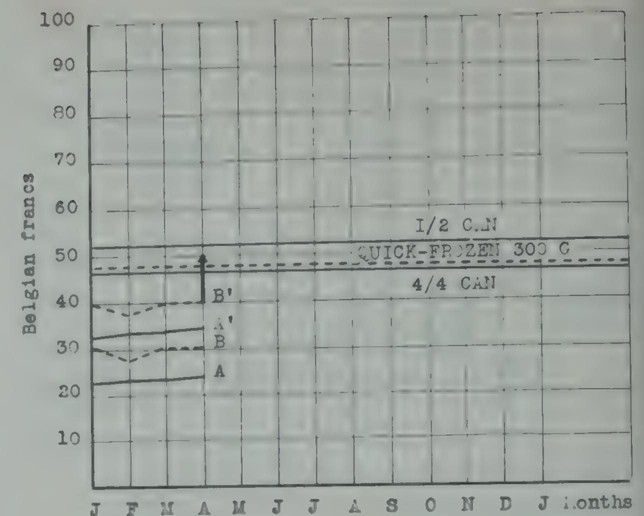
Cost to housewife (Belgian francs)

Waste : 60 %

Preparation : 15 minutes for 1 kg of fresh vegetable

Cooking : 30 minutes with 10 g of salt.

Cost : $\frac{100}{40}$ (Price + 0.03) + 0.65 + ($\frac{100}{40}$ x 3.75)
salt gas labour



10. CARROTS

Cost of preserved products (Belgian francs)

Size of cans	Weight of edible portion	Price	Price per kg of edible portion
1/2	280 g	9.50	33.92
4/4	580 g	18.00	31.03

Cost to housewife (Belgian francs)

Waste : old carrots, 20 % - new carrots, 50 %

Weight of bunches of new carrots : 600 g approximately

Preparation : 10 minutes per kg

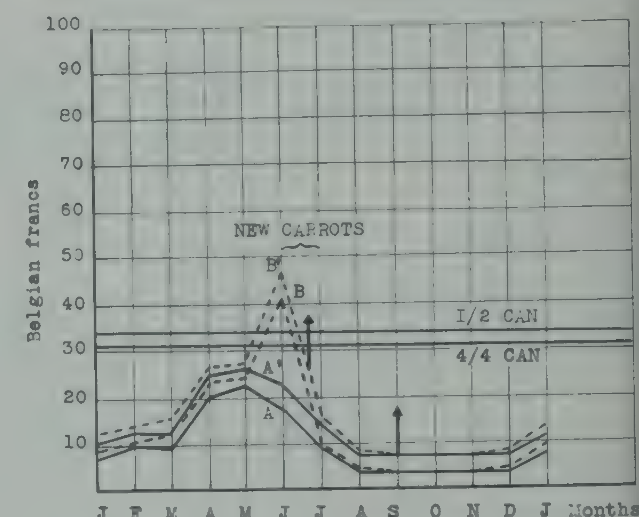
Cooking : 15 minutes with 10 g of salt.

Cost :

Old carrots : $\frac{100}{80}$ (Price per kg + 0.03) + 0.45 + ($\frac{100}{80}$ x 2.5)
salt gas labour

New carrots : $\frac{100}{50}$ (Price per kg + 0.03) + 0.45 + ($\frac{100}{50}$ x 2.5)
salt gas labour

It should be noted that canneries process new carrots, which are expensive , and that in September and October 1950 old carrots were very cheap. See Horticulture Index figures, p. 14.



11. CHERRIES

Price of preserved products (Belgian francs)

Kind of preserve	Packed in	Fruit content (1)	Sugar content	Price	Price per kg of fruit
Cherries in syrup	Jars 600 g	(65%) = 390 g	(18%) = 108 g	16.85	43.20
Cherries packed in water	4/4 cans (875 g)	570 g	0	17.50	30.70
Quick-frozen cherries		450 g	0	17.00	37.75

Price of fresh cherries (Belgian francs)

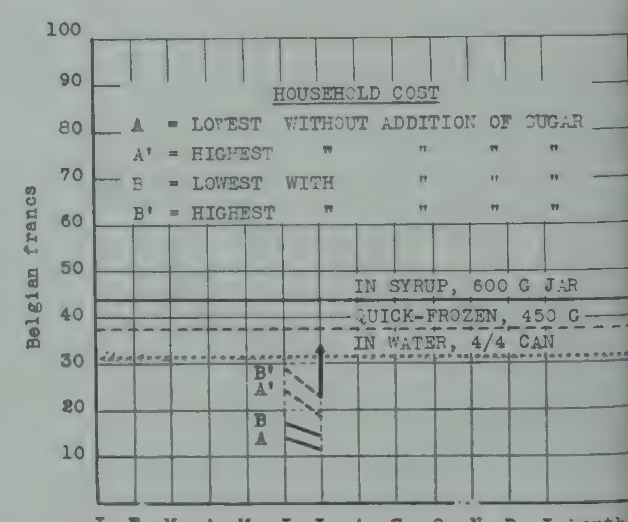
Waste : 22 %

Quantity of sugar to be added to obtain a weight equal to that of canned fruit in syrup : 18 % of net weight of can, i.e. 108 g for 390 g of fruit, which represents 277 g per kg of fruit, at Frs 14.- per kg, i.e. Frs 3.90.

Cherries in syrup : ($\frac{100}{78}$ x Price) + 3.90 } No cooking

Cherries in water : ($\frac{100}{78}$ x Price per kilo) } No labour

(1) See Annual Report, Campden, 1938 - Page 28.



12. QUICK-FROZEN STRAWBERRIES

Price of preserved products (Belgian francs)

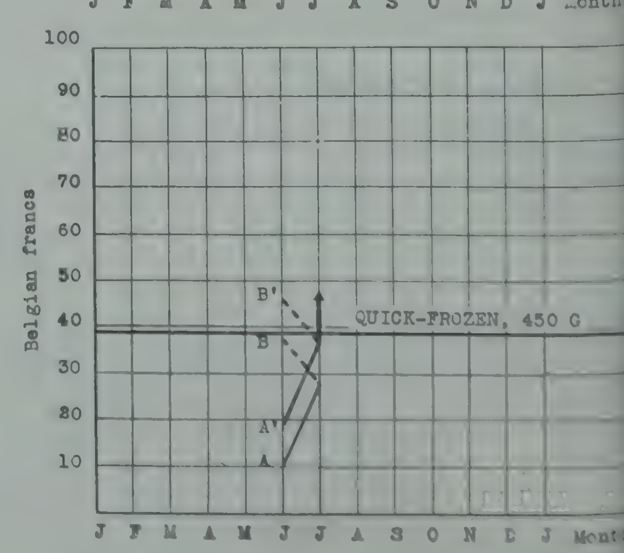
Package	Weight of edible portion	Price	Price per kg of edible portion
450 g	450 g	17.50	38.50

Cost of fresh fruit (Belgian francs)

Waste : 12 %

Labour : half an hour for removing stems and caps from 1 kg

Cost : ($\frac{100}{88}$ x Price per kg) + ($\frac{100}{88}$ x 7.50)
labour



13. PLUMS

Price of preserved products (Belgian francs)

Kind of preserve	Packed in	Fruit content (1)	Sugar content	Price	Price per kg of fruit
Plums in syrup	600 g jars	(60%) = 360 g	(18%) = 108 g	14.50	40.27
Plums in water	4/4 cans (875 g)	525 g	0	13.60	25.90

Cost of fresh fruit (Belgian francs)

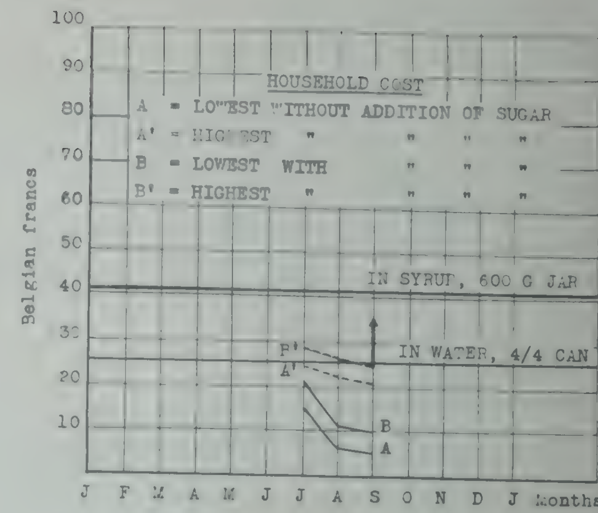
Waste : 15 %

Quantity of sugar to be added to obtain a weight equal to that of canned plums in syrup : 18 % of net weight per can, i.e., 108 g for 360 g of fruit, or 300 g per kg of fruit, at Frs 14.- per kg, i.e., Frs 4.20.

Plums in syrup : ($\frac{100}{85}$ x Price) + 4.20) No cooking

Plums in water : ($\frac{100}{85}$ x Price)) No labour.

(1) See Annual Report, Campden, 1938, - Page 28.



14. GOOSEBERRIES

Price of preserved products (Belgian francs)

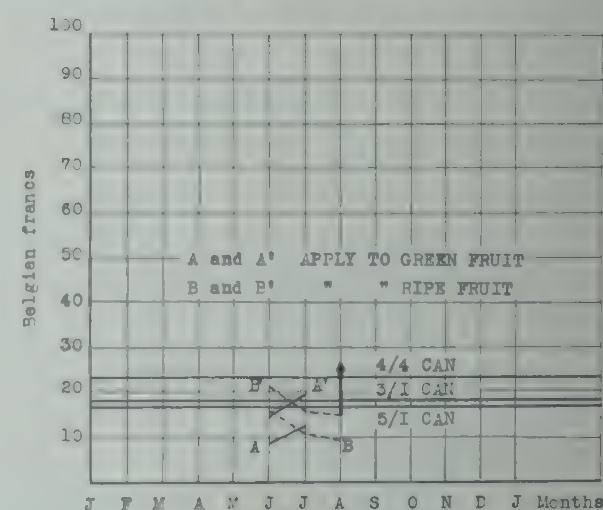
	Packed in	Fruit content (1)	Price	Price per kg of fruit
Gooseberries, in water	4/4 can (875 g)	(65%) 570 g	13.25	23.25
" " " "	3/1 can (2.8 kg)	(65%) 1,820 g	33.00	18.13
" " " "	5/1 can (4.7 kg)	(65%) 3,055 g	52.00	17.02

Waste : 4 %

Removing of stems and caps : 20 minutes per kg

Cost : ($\frac{100}{96}$ x Price per kg) + (Frs 5) labour

(1) See Annual Report, Campden, 1938 - Page 28.



15. APPLE SAUCE

Factory made products (Belgian francs)

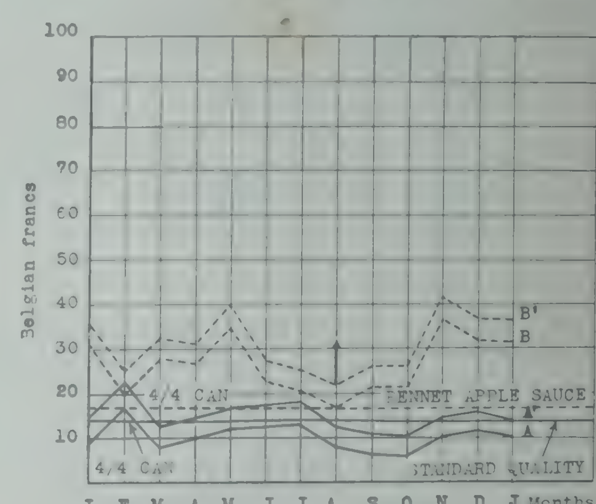
Kind	Packed in	Net weight	Price	Price per kg of fruit
Standard apple sauce with 20 % of sugar added	4/4 can	875 g	12.25	14.35
Rennet apple sauce with 20 % of sugar added	" "	875 g	14.95	17.08

Cost to housewife (Belgian francs)

$\frac{100}{84}$ (Price) + 0.40 gas + 2.80 sugar + ($\frac{100}{84}$ x 3.75) labour

Waste : 16 %
Cooking : 10 minutes
Labour : 15 minutes
1.1 kg of peeled apples + 0.2 kg of sugar = 1 kg of apple sauce

N.B. - The curves B and B' have no great significance; they correspond to the most expensive table fruit which, in general, is not used for apple sauces. It has been mentioned here for the sake of information.



16. RED CURRANT JELLY

Price of factory made jellies (Belgian francs)

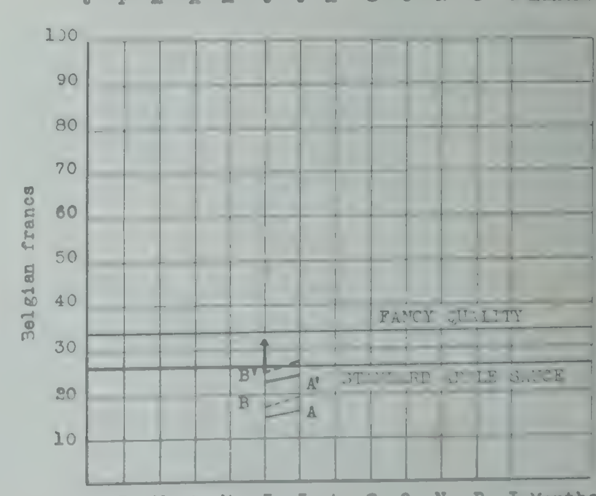
Quality	Packed in	Net weight	Price	Price per kg
Standard	450 g jar	450 g	11.90	26.44
Fancy	450 g jar	450 g	15.50	34.44

Cost to housewife (Belgian francs)

$$\frac{(\frac{100}{55}\ \text{x Price}) + \underset{\text{sugar}}{14} + \underset{\text{gas}}{0.70} + \underset{\text{labour}}{(7.5 + 7.5)}}{1.7}$$

1 kg of red-currant gives 0.55 kg of juice
Time of extraction : 30 minutes
Cooking : 15 minutes
Filling and closing jars : 15 minutes.

1 kg juice + 1 kg sugar = 1.7 kg jelly.



17. STRAWBERRY JAM

Price of factory made jam (Belgian francs)

Quality	Packed in	Net weight	Price	Price per kg
Standard	450 g jar	450 g	13.60	30.22
Fancy	450 g jar	450 g	18.00	40.00

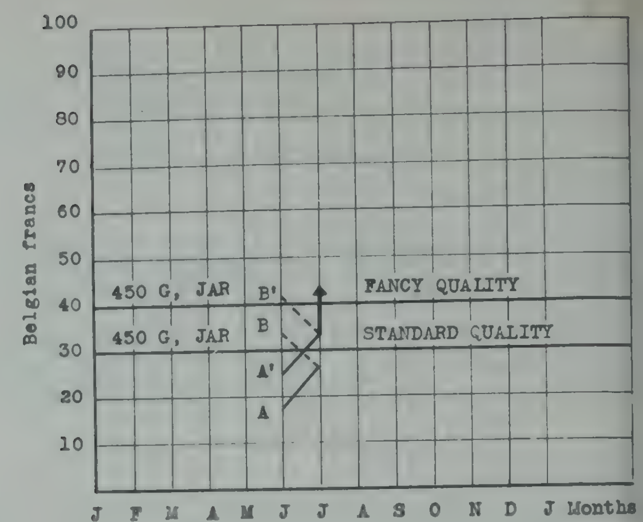
Cost to housewife (Belgian francs)

$$\frac{\frac{100}{88}\text{ Price} + \underset{\text{gas}}{0.63} + \underset{\text{sugar}}{14} + \underset{\text{preparing}}{\left(\frac{100}{88} \times 7.5\right)} + \underset{\text{filling and closing jars}}{3.75}}{1.6}$$

Waste : 12 %
Cooking : 20 minutes
1 kg prepared strawberries + 1 kg sugar = 1.6 kg of preserves.

Remark for all jams

Price of sugar has been estimated at Frs 14.-. In the fruit season cristallized sugar can be found at Frs 10.75 to 11.- a kilo.



18. CHERRY JAM

Price of factory made jam (Belgian francs)

Quality	Packed in	Net weight	Price	Price per kg
Standard	450 g jar	450 g	11.90	26.44
Fancy	450 g jar	450 g	15.50	34.44

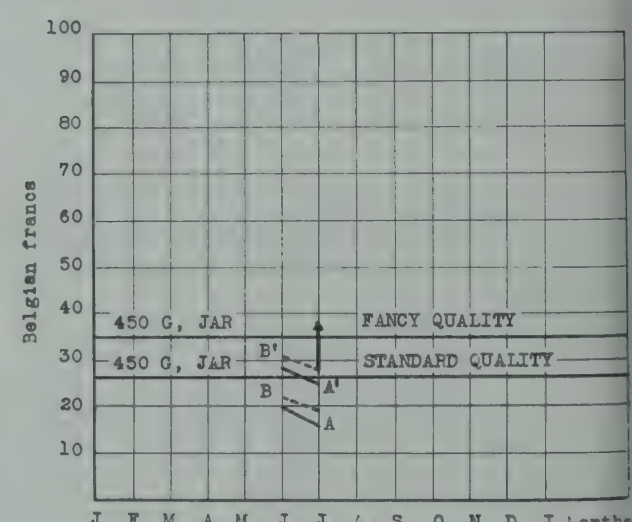
Cost to housewife (Belgian francs)

1/2 kg of cherries :...... 22 % waste
+ 1/2 kg red-currant juice : 20 of waste; juice yield : 55 %
+ 1/2 kg of sugar at Frs 14.-
Cooking : .... 20 minutes - yield : 1.6 kg.
Labour : .... 15 minutes for pitting cherries + 15 minutes for extraction of red-currant juice + 15 minutes for filling and closing jars.

Cost :

$$\frac{\frac{100}{78}\text{ (Price per 1/2 kg cherries)}}{1.6} + \frac{\frac{100}{80}\text{ (Price 1/2 kg red-currants} \times \frac{100}{55})}{1.6}$$

$$+ \frac{0.63 + 14 + \left(\frac{100}{79} \times 7.5\right) + 3.75}{1.6}$$



19. PLUM JAM

Price of factory made jam (Belgian francs)

Quality	Packed in	Net weight	Price	Price per kg
Standard	450 g jar	450 g	10.80	24.00
Fancy	450 g jar	450 g	12.25	27.22

Cost to housewife (Belgian francs)

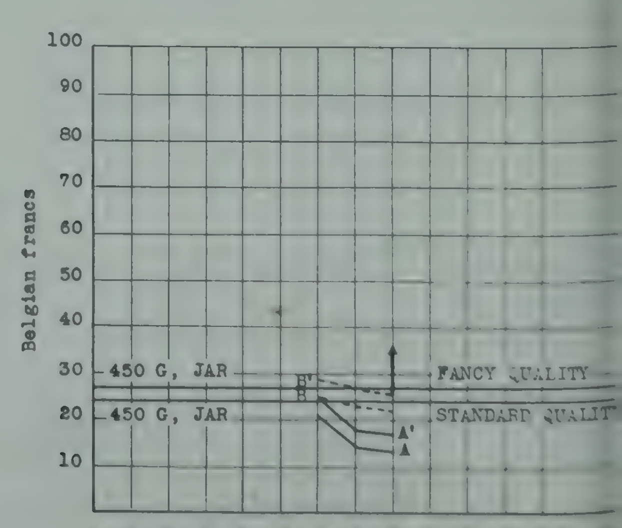
Waste

1 kg pitted fruit + 1 kg sugar, cooking 20 minutes, yield : 1.6 kg.

Labour : 10 minutes per kg for pitting
15 minutes for filling and closing jars.

Cost :

$$\frac{\left(\frac{100}{85} \times \text{Price per kg}\right) + 14 + 0.5 + \underset{\text{pitting}}{\left(\frac{100}{85} \times \frac{15}{6}\right)} + \underset{\text{filling jars}}{3.75}}{1.6}$$



20. CORNED BEEF

This product can be compared to home-boiled beef.

Price of preserved product (Belgian francs)	Product	Net weight	Price	Price per kilo of consumable product
	A brand	340 g	21.50	63.24
	B brand	340 g	23.00	67.64

Cost of home-boiled beef (Belgian francs)

	Waste : 10 %		
	Loss in cooking : 30 %		
	1.4 kilo of fresh meat (from Frs 35 to 45 per kilo)	49.00 to	63.00
	Vegetables ± 20 g (bouquet et herbs)	0.20	0.20
	Salt : 10 g at Frs 2.5 per kilo	0.03	0.03
	Cooking : 2 hours	1.60	1.60
		50.83 to	64.83
Labour :	15 minutes for preparation	3.75	3.75
Cost :	.... per kilo Frs	54.58 to	68.58

Remarks :

1) The average price of beef for boiling in 1950 increased from Frs 40 to 43 per kilo. Now the prices in stores vary between Frs 35 and 45 according to the cut.

Therefore, the fluctuations in price during the year are very small (Frs 3 per kilo) and do not necessitate working out the montly average cost.

2) In domestic cost, account must be taken of the fact that the cooking of meat gives a palatable broth (1.5 litre approximately) which has not been taken into account in making out the domestic cost.

21. LIVER PASTE

Price of preserved product (Belgian francs)	Quality	Packed in	Weight of edible portion	Price	Price per kilo of consumable product
	Standard	Round can	100 g	6.50	65.50
	Standard	Round can	200 g	12.50	62.50
	Superior	Oval can	80 g	10.25	126.87
	Superior	Large-size can	1,400 g	120.00	85.71
	Extra	Terrine	1,500 g	144.00	96.00

Domestic cost (in terrine) - (Belgian francs)

	1/2 kilo of pork liver at Frs 55.00 (waste 6 %)	29.20
	1/2 kilo fat pork meat at Frs 65.00	32.50
	1 onion (75 g) at Frs 8 per kilo	0.60
	10 g of salt (at Frs 2.50 per kilo)	0.03
	150 g of fat bacon at Frs 40.00 per kilo	6.00
	2 eggs at Frs 2.15 each	4.30
	Cost of ingredients	72.63
Cooking :	1/2 hour in oven (500 litres/gas/hour) 1.00 } 1/4 hour for pre-cooking liver .... 0.40 }.....................	1.40
Labour :	1/2 hour for preparing meat and liver .... } 1/4 hour for preparing bacon and filling terrine }................ 5 minutes for preparing raw liver .... }	12.50
Cost :	without including labour .... per kilo Frs	74.03
	including labour .... per kilo Frs	86.53

Remarks :

1) This cost price has been calculated on the basis of the prices of products in June 1951. It has not been possible to calculate the price for each month of the year, because fluctuations in the price of pork are sudden and irregular and on the other hand, because we have not monthly statistics of the prices of liver and eggs.

2) Account must be taken of the difference in quality between the home-prepared product and the standard factory-made product. The home prepared product can better be compared with the factory-made product packed in terrines (1.5 kg) or in large size cans (1.4 kg).

22. MIDDLE CUT OF PORK — MIDDLE CUT OF HAM

These products can readily be compared to home cooked roast pork.

Price of preserved product (Belgian francs)

Product	Type of can	Weight of edible portion	Price	Price per kilo of consumable product
Middle cut ham	Mandoline (1/4 ham)	850 g	125.-	147.05
Middle cut pork (in one piece)	-	700 g	102.-	145.71
Middle cut pork (in slices)	-	110 g	23.-	209.09

Domestic cost (Belgian francs)

	Price one kilo of meat	65.00	to	80.00
	10 g of salt	0.03		0.03
	70 g of margarine at Frs 30 per kilo	2.10		2.10
Cooking :	10 minutes for heating oven (800 litres/gas/hour)) .... 1/2 hour at 400 litres/hour ....)	1.10		1.10
	30 % of loss in cooking (therefore, 700 g of cooked meat cost)	68.23	to	83.23
	Price per kilo of cooked meat	97.47	to	118.90
Labour :	Supervision 1/2 hour at Frs 15..	7.50		7.50
Cost price :	.... per kilo Frs	104.97	to	126.40

23. HERRINGS AND PILCHARDS IN TOMATO SAUCE

Price of preserved product (Belgian francs)

Type of product	Net weight	Net weight without sauce	Tomato sauce	Price	Price per kilo of fish	Sauce per kilo of fish
Herrings	400 g	325 g	75 g	11.00	33.84	230.8 g
Pilchards	400 g	325 g	75 g	14.00	43.07	230.8 g

Domestic cost (Belgian francs)

	Fresh herring at Frs 8 per kilo	
	Waste : 40 % .... $\frac{100}{60}$ x 8 = ...	13.33
	Ingredients per kilo of fish :	
	60 g of flour at Frs 8 per kilo	0.48
	70 g of pea-nut oil at Frs 36 per 750 ml	3.40
	15 g of salt	0.05
	40 g of margarine at Frs 30.00 per kilo	1.20
	70 g of tomato extract	2.90
	50 g of onions	0.40
Cooking :	fish 20 minutes; sauce 15 minutes	1.10
Labour :	3/4 hour	11.25
Cost :	without labour .... per kilo Frs	28.86
	with labour .... per kilo Frs	34.11

N.B. : Fresh herring is in season during August - September - October.
The average price on the Ostende market was Frs 3.25 in 1950.

24. FILLETS OF MACKEREL IN OLIVE OIL

Price of preserved product (Belgian francs)

Type of can	Net weight	Weight of fish in fillets	Weight of fresh fish	Weight of olive oil	Price	Price per kilo of fillet	Quantity of oil per kilo of fillet
1/4 Club 30	125 g	105 g	300 g	20 g	7.40	70.47	190 g
1/8 Club 30	93 g	76 g	243 g	17 g	5.90	77.43	223 g

Cost to housewife (Belgian francs)

Waste : 66 %
Price of fresh fish : Frs 10 per kilo
Quantity of oil equal to that used in can : ± 220 g per kilo of fillet.
Price of olive oil : Frs 39 per 425 g, i.e., Frs 91.76 per kilo

Labour : 30 minutes for cleaning 1 kilo of fresh fish.

Cost : $(\frac{100}{34} \times 10) + \underbrace{20.18}_{\text{oil}} + \underbrace{(3 \times 7.50)}_{\text{labour}}$

Cost : without labour .... Frs 50.18 per kilo of fillets.

with labour .... Frs 72.68 per kilo of fillets.

Remark : Price of mackerel on the Ostende market : October 1950 .... : 3.75 Frs on average
September 1950 .... : 4.25 Frs on average
August 1950 .... : 3.76 Frs on average

The price to consumer is approximately 3 times the price of the market.

25. SHRIMPS

Price of preserved product (Belgian francs)	Type of preserve	Packed in	Weight of edible portion	Price	Price per kilo of consumable product
	Quick-frozen	100 g	100 g	17.00	170.00
	Canned	1/4 round can	100 g	21.00	210.00

Price of fresh shrimps (Belgian francs)

Prices of fresh shrimps show great fluctuations. The following prices have been noted :

	At local fishmongers	In large stores
Price of fresh non-prepared shrimps, per kilo	60.00	25.00
Price of fresh prepared shrimps, per kilo	160.00	100.00

Waste in preparing : 66 %

Labour : for one kilo of fresh shrimps : 1 hour

Cost : $(\frac{100}{34} \times \text{price}) + \underbrace{(\frac{100}{34} \times 15)}_{\text{labour}}$

which gives : without labour .... per kilo Frs 73.53 to 176.46

with labour : .... per kilo Frs 118.23 to 221.16

26. SOUPS

It is difficult to compare the cost prices of factory canned or dehydrated soups with that of home preparation.

This would require a special and rather lengthy investigation. We shall confine ourselves to two standard soups, sold in cans and containing meat extract.

a. Tomato soup

Price of soup in can (per 2 litres)	Size of cans	To be diluted to	Price per can	Price of 2 litres of soup
	400 g	2 litres	19.50	19.50
	200 g	1 litre	12.50	24.00

Cost to housewife (Belgian francs)

Ingredients required for 2 litres of soup :

(2 x 70 g tomato extract
(400 g potatoes
(60 g onions
(50 g celery
(60 g margarine
(15 g salt
(Meat to be taken at Frs 10 (voir remark, p.13)

Cooking : 3 hours

Labour : 1/4 hour

Cost : (Price of ingredients) + $\underbrace{4.95}_{\text{gas}} + \underbrace{0.036}_{\text{salt}} + \underbrace{(3.75)}_{\text{labour}}$

Remark :

If the housewife prepares the soup with meat extract, cost will be less by Frs. 5.80, representing the difference between price of meat and price of corresponding meat extract (see remark), i.e. Frs. 2.50 and the shorter cooking time (1 hour instead of 3), i.e., Frs. 3.30.

Cost prices are comparatively stable during the year, therefore they are sufficiently shown by means of a table.

COST PRICE FOR TWO LITRES OF SOUP (Belgian francs)					
Month :	January	March	June	September	November
Packed in					
400 g can	19.50	19.50	19.50	19.50	19.50
200 g can	24.00	24.00	24.00	24.00	24.00
Home-preparation					
I. With meat					
a. without labour	26.25	26.75	25.05	24.55	24.95
b. with labour	30.00	30.50	28.80	28.30	28.70
II. With meat extract					
a. without labour	20.45	20.95	19.25	18.75	19.15
b. with labour	24.20	24.70	23.00	22.50	22.90

b. Julienne soup

Price of canned soup (per 2 litres)	Size of can	To be diluted to	Price per can	Price of 2 litres of soup
	200 g	1 litre	9.25	18.50

Cost to housewife (Belgian francs)

The factory-made soup in can of 200 g corresponds to 95 g of vegetables and to a meat extract obtained from 320 g of fresh meat, i.e., for 2 litres : 190 g vegetables, 640 g meat.

Quantity of meat to be rekoned for home-made soup :

On the basis of Frs. 10 per kilo for meat, for 2 litres of tomato soup (corresponding to 560 g of meat) the cost is here : 10 x 640/560 = Frs. 11.50.

The 190 g of vegetables may for instance comprise (50 g carrots (50 g leeks (50 g celery (40 g onions

Moreover, home-made soup requires 400 g of potatoes and 60 g of margarine.

Cooking : 3 hours; salt : 15 g; labour : 35 minutes.

Cost : (Price of ingredients) + 4.95 gas + 0.036 salt + (8.75) labour

N.B. If the housewife prepares her soup with meat extract, cost will be Frs. 2.90 less for meat, and Frs. 3.30 for gas, i.e., a total reduction in cost of Frs. 6.20.

COST PRICE FOR TWO LITRES OF SOUP (Belgian francs)					
Month :	January	March	June	September	November
Packed in					
200 g can	18.50	18.50	18.50	18.50	18.50
Home-preparation					
I. With meat					
a. without labour	24.35	25.25	22.25	20.95	21.75
b. with labour	33.30	34.00	31.00	29.70	30.50
II. With meat extract					
a. without labour	18.35	19.05	16.05	14.75	15.55
b. with labour	27.10	27.80	24.80	23.50	24.30

Remarks

For the purpose of indicating a cost for the meat used in preparing the two soups in question, we had to make certain tests and analyses, and then agree on certain distribution of values.

We think we should clarify these points, although it is a matter of technical data.

It is of course obvious that we have only proceeded to experimental tests. A strictly exact comparison of the respective cost prices of canned soups and home - made soups would call for knowledge of the exact manufacturing recipes, which are secret.

About 1.080 kg of lean and boneless shin meat was put to boil in 3 1/2 litres of cold water. It was kept boiling for about 2 1/2 hours until the meat suitably cooked. The following results were obtained :

With respect to the meat	(770 g of boiled meat (loss of weight : 35 %); (a total loss of 12.1 % of dry substance (fat not being taken into account); (a total loss of 12 % of proteins.
With respect to the broth (3 1/2 litres)	(A corresponding enrichment with, in addition, fat content of about 2 % of the weight of the fresh meat.

After this first boiling the meat was subjected to a second extraction process in boiling water; 100 g of meat were disintegrated in the Waring-Blendor and boiled under back-flow cooler with one litre of water.

The one litre of broth obtained contained 7.39 g of total proteins. Therefore, under the same conditions, 770 g of meat would yield 56.9 g of proteins, i.e. 26.8 % in relation to the proteins of the precooked meat, or 23.6 % in relation to the proteins of fresh meat. This shows the influence of disintegration of raw material before extraction in boiling water.

On the other hand, a laboratory which specialises in analyses of meat extracts and soups, communicated the following figures to us :

after keeping 690 g of meat and 265 g of bones boiling for 3 hours, the quantity of meat remaining was 530 g; the broth weighed 1.180 g and the fat, 82 g.

The broth contained 1.365 g of creatinin.

In view of the foregoing we may argue as follows :

1) tomato soup, which is in large supply on the market, contains 0.840 g or creatinin per can of 400 g of soup (to be diluted to 2 litres). From the above explanation, it will be seen that this amount of creatinin is yielded by the broth resulting from cooking 424 g of meat plus 160 g of bones, i.e. 584 g, costing on an average Frs. 40 per kilo (Frs. 35 to 45) or Frs. 23.30.

The laboratory officials are of the opinion that the market value of the boiled meat is one half that of fresh meat.

Therefore the cost of the meat for the 2 litres of broth is Frs. 11.65.

2) On the other hand, we are always told that fresh meat contains from 0.25 to 0.75 % of creatin, i.e. an average of 0.5 % (convertible into creatinin through hydrolysis). Therefore, in order to obtain the 0.840 g of creatinin corresponding to 2 litres of soup, 170 g of fresh meat must be used, presuming that the meat can be completely drained of its substances. In practice, it is reckoned that one half of the value of such meat remains in the boiled meat. Therefore 340 g of boneless fresh meat will have to be used, which, at Frs. 60 per kilo, will cost Frs.20.40 one half of which is to be taken as the value of the boiled meat itself. Therefore the cost value of the meat contained in two litres of soup is Frs.10.20.

3) Taking as a basis the composition of meat extracts, the following results are obtained : the extract contains an average of 77 % dry substances without salt (76 to 79 %), and 57 % total proteins on the basis of N x 6.25 (56 to 58 %), out of which 5 % is creatinin.

The 0.840 g creatinin which is necessary corresponds therefore to 9.5 g of total proteins. Our experiment showed that 1.800 kilo of fresh boneless meat, cooked for 2 1/2 hours, produced a broth containing 35.1 g of total proteins. The 9.5 g of proteins required will therefore correspond to 300 g of boneless meat which is worth Frs.60 a kilo, i.e. Frs.18. One half of such cost being taken as the value of the boiled meat itself. This leaves Frs.9 as the cost value of the meat required for the two litres of soup.

It seems from the three above methods of calculation that an average value of Frs.10 can be reckoned as the cost of the meat for 2 litres of soup.

4) Lastly, in the case of the housewife who prepares her soups with meat extract, the values are as follows :

the extract contains 5 % creatinin.

Therefore 0.40 g creatinin is produced by 16.4 g of extract which costs :

- 0.393 franc per gram in 500 g packages;
- 0.432 franc per gram in 125 g packages;
- 0.477 franc per gram in 65 g packages;

i.e., for two litres of soup .... : Frs 6.44
Frs 7.08
or Frs 7.82

according to the size of the package purchased.

As the housewife usually purchases the extract in 65 or 125 g pots, the cost of meat extract contained in two litres of soup can be reckoned on the basis of Frs 7.50.

APPENDIX - HORTICULTURAL INDEX PUBLISHED BY THE MINISTRY OF AGRICULTURE
(partial reproduction)(+)
Reference period : 1936/37/38 = 100

	Stringless beans	Peas	Spinach	Carrots	Tomatoes	Asparagus	Apples	Plums	Cherries	Gooseberries	Red currants
MAY											
1947	-	-	595	-	-	470	141	-	-	159	-
1948	-	-	195	-	-	362	171	-	-	132	-
1949	-	-	135	-	-	395	192	-	-	215	-
1950	-	-	234	-	-	359	191	-	-	173	-
JUNE											
1947	-	319	351	-	-	516	135	-	112	108	128
1948	-	287	290	-	-	385	226	-	145	184	209
1949	-	428	213	-	-	464	-	-	140	173	157
1950	-	169	162	-	-	412	196	-	115	141	167
JULY											
1947	357	434	236	-	-	424	170	98	139	161	129
1948	381	360	456	-	-	-	427	138	203	187	170
1949	474	184	184	-	-	-	216	152	144	181	150
1950	290	269	193	-	-	365	295	128	110	201	123
AUGUST											
1947	573	381	727	-	150	-	113	105	-	-	-
1948	476	392	377	-	323	-	226	114	-	-	-
1949	498	504	856	-	269	-	185	90	-	-	-
1950	95	342	196	-	66	-	234	123	-	-	-
SEPTEMBER											
1947	877	-	787	695	473	-	66	197	-	-	-
1948	190	372	172	181	789	-	207	163	-	-	-
1949	448	352	453	677	124	-	174	112	-	-	-
1950	167	316	202	181	174	-	198	144	-	-	-
OCTOBER											
1947	553	-	829	744	427	-	95	-	-	-	-
1948	216	-	194	200	286	-	250	-	-	-	-
1949	431	-	304	646	102	-	203	-	-	-	-
1950	384	-	423	197	203	-	200	-	-	-	-

The prices of horticultural products vary greatly from one year to another. Those of canned products are substantially more stable, as manufacturers can base their prices on averages.

(+) Extract from "Revue de l'Agriculture" - year 1950 - published by the Economic Department of the Belgian Ministry of Agriculture.

TABLE I. CENSUS OF FOOD RETAILERS AS OF DECEMBER 31, 1942

Regions	Butchers Pork-butchers	General food	Fruit, vegetables potatoes	Fish	Poultry
ANTWERP	1,912	6,649	1,168	507	67
BRABANT	3,724	9,695	2,508	554	172
WEST FLANDERS	2,221	6,535	1,149	406	146
EAST FLANDERS	3,789	8,562	1,756	544	211
HAINAULT	3,059	8,451	1,677	154	211
LIEGE	1,693	5,421	1,265	52	16
LIMBURG	762	3,476	482	34	16
LUXEMBURG	340	1,836	102	2	29
NAMUR	699	2,903	282	24	4
TOTAL FOR THE WHOLE COUNTRY ..	18,196	53,528	10,389	2,277	668

In 1941, in Belgium there where :

1 butcher - pork-butcher for .... 501 inhabitants
1 fishmonger .... " .... 5,835 "
1 greengrocer .... " .... 1,366 "
1 grocer .... " .... 161 "
1 poulterer .... " .... 13,774 "
1 dealer in brand foods. " .... 14,728 "

Districts : ANTWERP .... : 1 food dealer for .... 198 inhabitants
BRUSSELS .... : 1 " " " .... 183 "
GHENT .... : 1 " " " .... 166 "
LIEGE .... : 1 " " " .... 159 "
CHARLEROI .... : 1 " " " .... 139 "
FOR THE WHOLE COUNTRY .. : 1 " " " .... 129 "

Present tendency in the food trade (1947-1951) :

1) Decrease in the number of food shops;
2) addition of sundry articles to the range of products sold in the same store (suppression of specialisation);
3) increase in the number of "general food" stores, to the detriment of the others.

TABLE II. NUMBER OF RETAIL BUTCHERS, PORK-BUTCHERS, AND BUTCHER-PORK-BUTCHERS IN BUSINESS ON DECEMBER 31, 1947

Regions	Butchers				Pork-butchers				Butchers-Pork-butchers				
	A	B	C	D	A	B	C	D	A	B	C	D	P
ENTIRE COUNTRY	14,302	-	-	-	346	-	-	-	3,810	-	-	-	8,653
ANTWERP	1,775	76	22	2	17	-	-	-	41	142	43	8	1,310
BRABANT	2,676	178	34	9	101	21	13	2	863	185	51	5	1,832
(BRUSSELS DISTRICT)	(1,794)	-	-	-	(90)	-	-	-	(704)	-	-	-	
WEST FLANDERS	2,191	80	13	2	20	1	-	-	196	50	9	3	1,009
EAST FLANDERS	3,477	69	7	1	35	5	1	2	138	36	6	-	1,231
LIEGE	572	32	11	1	127	24	11	-	1,096	153	49	-	973
HAINAULT	2,325	39	10	1	31	3	4	-	932	71	21	2	1,236
LIMBURG	680	7	4	-	1	2	1	-	53	12	1	-	485
LUXEMBURG	154	9	1	-	4	2	-	-	193	27	4	-	214
NAMUR	452	22	4	-	10	4	-	-	298	40	9	1	359

A = Shops without employee
B = " with 1 employee
C = Shops with to 2 to 4 employees
D = " with more than 4 employees
P = Population of regions and of the entire country in thousands of inhabitants

TABLE III. NUMBER OF FOOD RETAILERS IN BUSINESS ON DECEMBER 31, 1947

Professions	Antwerp	Brabant	Liege	Namur	W.Fl.	E.Fl.	Limburg	Luxemburg	Hainault
FRESH AND PRESERVED MEAT DEALERS									
No emp. (1) A. (2)	1,182	1,591	638	328	1,409	1,588	428	160	1,416
B.	28	47	25	3	24	65	5	6	26
1 emp. (A + B)	11	12	10	4	5	6	2	–	2
≥ 2 emp. (A + B)	4	7	3	1	–	1	1	–	2
FISH, SHELL-FISH and MOLLUSCS DEALERS									
No emp. (1) A. (2)	776	813	73	25	818	787	67	4	203
B.	22	30	3	2	41	29	4	–	8
1 emp. (A + B)	16	24	4	2	19	9	1	–	6
≥ 2 emp. (A + B)	13	15	7	–	22	2	–	–	3
VEGETABLES & FRUIT AND ASSIMILATED DEALERS									
No emp. (1) A. (2)	957	1,887	1,110	241	973	1,527	526	101	1,076
B.	68	216	125	22	79	178	65	10	100
1 emp. (A + B)	14	31	17	3	16	19	18	1	14
≥ 2 emp. (A + B)	7	16	12	3	–	4	10	–	11
DEALERS IN COLONIAL PRODUCE									
No emp. (1) A. (2)	769	1,408	435	84	782	1,605	1,307	57	631
B.	22	23	5	3	26	51	9	2	25
1 emp. (A + B)	11	5	2	1	2	10	–	–	6
≥ 2 emp. (A + B)	8	10	4	3	8	12	1	–	12
CROCERS									
No emp. (1) A. (2)	3,535	3,821	1,890	859	4,793	5,450	1,535	582	3,186
B.	35	58	18	8	65	126	19	4	38
1 emp. (A + B)	31	35	13	7	32	51	5	4	4
≥ 2 emp. (A + B)	53	33	2	2	22	25	6	4	3
GROCERY + HABERDASHERY + TOBACCO + VEGETABLES + FRUIT DEALERS									
No emp. (1) A. (2)	3,149	4,372	3,726	1,915	2,409	3,229	979	1,119	5,637
B.	69	100	53	28	76	118	18	17	98
1 emp. (A + B)	50	58	60	11	24	14	13	8	33
≥ 2 emp. (A + B)	18	36	49	9	16	16	7	2	26
GENERAL FOOD DEALERS OTHER THAN THE FOREGOING									
No emp. (1) A. (2)	666	2,079	941	248	402	240	38	137	1,063
B.	53	50	21	4	33	16	3	1	34
1 emp. (A + B)	–	53	29	8	–	1	2	6	29
≥ 2 emp. (A + B)	6	74	57	8	2	1	–	7	34
DEPARTMENT STORES									
No emp. (1) A. (2)	–	–	–	–	–	1	2	1	1
B.	–	–	–	–	–	–	–	–	–
1 emp. (A + B)	–	–	–	–	–	–	–	–	–
≥ 2 emp. (A + B)	2	19	1	3	9	6	1	–	1
CHAIN STORES									
No emp. (1) A. (2)	–	–	2	2	1	–	1	–	4
B.	–	–	–	–	–	–	–	–	–
1 emp. (A + B)	–	–	–	–	–	–	–	–	–
≥ 2 emp. (A + B)	1	1	3	–	1	–	–	–	–
CO-OPERATIVE STORES									
No emp. (1) A. (2)	–	1	2	–	–	–	27	2	5
B.	–	–	–	–	–	–	–	–	–
1 emp. (A + B)	2	6	4	–	–	4	–	–	5
≥ 2 emp. (A + B)	7	31	4	3	10	9	2	2	15

(1) No emp. = without employee.

(2) A = retailers only) including itinerant traders
B = wholesalers and retailers)

V. CONCLUSIONS

1. Outside of horticultural seasons, fruit and vegetables preserved by the Appert process or by quick-freezing, are far less expensive than the corresponding fresh foods after the latter have been prepared in the home.

2. Even when the corresponding fresh foods are in season, the prices of preserved products are frequently very advantageous, especially if account is taken of the additional expense involved by the acquisition and preparation of the fresh foods.

3. Canned soups of belgian manufacture are sold at very attractive prices. Detailed comparisons, made on "Tomato" and "Julienne" soups, two of the most popular kinds, show that canned soups are cheaper than the corresponding traditional home prepared soups.

4. Fruit and vegetables preserved by the Appert process are stable when stored under normal conditions and are more easily procurable than the corresponding fresh foods, especially out of the short home production seasons.

5. Although canned meat and fish are more in the way of specialities which it is difficult to compare with fresh products, these foods, which are easily procurable, can be considered as costing only slightly more than those prepared in the home if account is taken of all items of expenditure involved.

6. Quick-frozen fruit and vegetables which are fairly difficult to procure, are not substantially more expensive that the sterilized products. In certain cases even their prices are very close to those of the latter.

7. Quick-frozen fish does not cost more than fresh fish, but is still more difficult to obtain. In a not fardistant future it is very likely that fresh fish will be supplanted to a great extent by frozen fish, which is more easily prepared.

XXIX. COMPARISON BETWEEN A FEW DISHES PREPARED WITH CANNED FOOD AND THE SAME DISHES PREPARED WITH FRESH FOOD, IN DENMARK

by F. BRAMSNAES, Direktor, Fiskeriministeriets Forsøgslaboratorium (Denmark)

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In 1950 an exhibition was held in Copenhagen, the aim of which was to show the rationalization of woman's work in the home; the use of canned food was naturally a part of this exhibition. The canned products stand did not carry on the usual kind of propaganda, but really tried, by means of scientific results and popular cooking experiments, to show the housewife, the advantages of the use of canned food.

The canned food stand gave the following three kinds of information :

1) information on the nutritive value of canned products, compared, on the one hand with food cooked in the ordinary way, and on the other hand with home-preserved foods;
2) a comparison between the money and time spent on two meals, one cooked in the traditional way and the other composed as far as possible of canned products;
3) practical information on the storage and use of canned products, and a few words about the laws and regulations which guarantee the supply of good quality products.

In this paper I shall only deal with the first two of these items.

I. NUTRITIVE VALUE

In order to eradicate the longstanting misconception, that canned food is of low nutritive value, scientists in France, the U.S.A., England and Germany made some fundamental experiments in the early thirties. As it is exceedingly difficult to make such experiments on human beings, animals are used where their reactions to the food in question correspond to those of man. Generally, white rats and guinea-pigs are used. The experiments proved that when a comparison between canned food and fresh, uncooked food is made, raw food is the best; but when canned food is compared with the usual kitchen - prepared food, canned food is as good as the usual food, and in some cases even better.

The results of such experiments made in various countries were illustrated for visitors by pictures accompanied by the following comments :

FRANCE (MACHEBOEUF and CHEFTEL's work)

Experimental animals fed exclusively on canned food. 14 generations, each with 10-14 young, showed completely normal growth. The experimental animals were quite as healthy as those fed on raw food.

U.S.A. (KOHMAN, EDDY and GURIN's work)

The animals fed exclusively on canned food showed unusually good ossification and reproduction ability. Repeated experiments proved that canned food gave better results than food prepared in the ordinary way.

GERMANY (NEHRING's work)

There was evidence that the content of vitamins and mineral salts in canned fruit and vegetables is about equal to that of the raw products. Meals consisting of canned food has even a higher vitamin-content than ordinary food.

If, in addition to information on these scientific studies, it is desired to show the public practical results, the many polar expeditions give striking proof on the excellent quality of canned food. For the Copenhagen exhibition we chose the famous French CHARCOT expedition to East Greenland in 1932 - 33, during

which 15 men lived chiefly on suitably varied canned food for 13 months. Nobody suffered from lack of vitamins, although the fruit brought was not consumed. Nutrition, the visitor was informed, can be satisfactorily assured by means of varied canned products.

These polar expeditions give striking proof of the nutritive value, the good quality and excellent conservation properties of canned foods, even under the most difficult circumstances. You will notice that much attention is paid to the fact that it is absolutely necessary to have a wide variety of canned foods.

The next thing that was shown was what happens to three important constituents in our food during the process of canning. In our daily diet we need constituents which will provide us with energy for working, walking, etc., and constituents which can build up and maintain our bodies. Energy supplying constituents are measured in calories. The most important of the substances we need for building up and the maintaining of our bodies are proteins and vitamins. It is a well-established fact that the calories and proteins content of food is not reduced either in the kitchen or in the canning factory. Here, no account is taken of the fact in both cases the water, in which the food is cooked may be left unused.

However, as regards vitamins, we must always allow for some loss during the canning process. Repeated experiments have proved that vitamins are better preserved in food during commercial canning than in home cooking. From the results of exact experiments concerning these problems it is estimated that the loss of vitamins as a whole, i.e. vitamins A, B, C, D, E, etc., amounts to 25 % during a canning process but to 50 % when the food is prepared in the kitchen. These facts were demonstrated to the Danish public by proper illustrations with the following texts :

" The calory and protein content of canned food is fully equal to that of the corresponding amount of " fresh food. Nothing is lost during the canning process ".

" The vitamins in fruit and vegetables are better retained during preservation in the canning factory " than in the kitchen. Even when some of the vitamins are destroyed during canning, the loss of vitamins the " food suffers when prepared in the kitchen is far greater ".

In the following paragraphs only vitamin C, ascorbic acid, the most sensitive of all the vitamins, will be discussed. Experiments on this subject have proved that during the first 24 hours after gathering vegetables lose a considerable part of their vitamins. It is estimated that at normal temperature about half the vitamins are destroyed during this period. It is therefore of great importance for the canning factory to receive the vegetables as soon as possible after they have been gathered. In a modern canning factory in Denmark, the time that elapses between gathering and canning of peas, for instance is only 4-6 hours, while the peas usually take 24 hours, and often more, after they are picked to reach the urban kitchen. During canning the vegetables are, moreover, cooked in closed containers where very little air is present, and is this way the vitamin C is far better preserved than by the usual method of cooking.

These facts were illustrated by pictures with the following commentary :

" May we have the pleasure of introducing Mr and Mrs. Vitamin C ? They have just been picked and are " full of energy and enterprise. The couple has however, a queer characteristic: they cannot stand fresh air, " and because of this it is important for them to be eaten or preserved as soon as possible ".

" The distance to the factory is fairly short, the peas generally get there a few hours after they are " picked ".

" The way to your kitchen is, on the other hand, long and full of obstacles for the vitamins ".

" In the factory the goods are cooked in air - tight, well - filled cans. The vitamin C is only shightly " damaged in this way ".

" During preparation in the kitchen vitamin C is greatly exposed to air and undergoes a far bigger loss " than in the factory ".

Another picture extended the comparison to home canned foods as regards the preservation of vitamin C, and emphasized the chances of the canning factory getting the goods when they are still quite fresh and much sooner than the urban housewife. It should be noted that the figures shown as well as a good many of the above mentioned calculations do not concern the rural housewife or the preservation of home - grown vegetables, where green vegetables for instance, can be canned immediately after picking. The exhibition was, however, held in Copenhagen, a city with more than a million inhabitants, with its resulting difficulties in getting fresh food.

The information given at this exhibition on the nutritive value of food was exclusively based on impartial experiments and surprised even professional people. It was decided to ask various salesmen from the Danish canning factories to act as guides at the stand. Before the exhibition was opened I was asked to give these salesmen a general idea of what the stand contained. Afterwards, two elderly salesmen told me that they did not wish to act as guides at the stand, for what I had said could not possibly be true and would mislead people. And these men had sold canned goods for twenty years !

II. COMPARISON BETWEEN PRICES AND TIME

In collaboration with the National Council of Domestic Science and Economy and other women's organizations, the exhibition committee for food preservation studied the question of price and time with regard to the use of canned food as compared with food prepared from fresh materials. A quick and experienced cook was asked to prepare the same dinner in two different ways. One of the meals was to be cooked in the ordinary way, the other one was to be composed of as much canned food as possible. The test meal was a typical Danish Sunday dinner for 6 people : tomato soup with fish - balls, boiled pork tongue with stewed vegetables and preserved pears as a sweet.

The experiments were made at the end of August.

The results are shown in the following tables.

TABLE I. TIME REQUIRED FOR PREPARING A SUNDAY DINNER WITH FRESH OR HOME CANNED PRODUCTS

	Working time in minutes	
Tomato soup with fish-balls :		
Washing and cutting up tomatoes, peeling onions	5	
Sieving tomatoes	4	
Stirring, thickening and flavouring	5	
Cooking fish-balls	6	
Total working time for the dish		20
Boiled pork tongue with stewed vegetables :		
Washing and scraping tongues	3	
Removing scum and adding salt	2	
Skinning tongues	13	
Peeling and cutting up carrots	16	
Opening a can of peas	2	
Washing and chopping parsley	8	
Thickening and flavouring	7	
Carving tongues and dishing up	3	
Dishing up carrots and peas	1	
Total working time for the dish		55
Bottled pears :		
Opening bottles and serving	3	
Total working time for the dish		3
Total working time for cooking the dinner		78
Serving		10
Time for cooking tongues. The actual time was 72 minutes, but it is reckoned that 57 minutes can be used effectively for other work. Therefore there remains		15
Working time for home-preservation of peas, shopping time included, and a 20 % loss from unsuccessful canning		38
Working time for home-preservation of pears, shopping time included		46
Other shopping time		45
Total time		232

TABLE II. TIME REQUIRED FOR PREPARING A SUNDAY DINNER WITH CANNED PRODUCTS

	Working time in minutes	
Tomato soup with fish-balls :		
Opening cans	4	
Pouring contents into saucepan and peeling onions	4	
Stirring, thickening, flavouring and adding fish-balls	7	
Total working time for the dish		15
Boiled pork tongues with stewed vegetables :		
Opening and emptying cans	5	
Pouring vegetables into saucepan	2	
Stirring, thickening and flavouring	4	
Washing and chopping parsley	8	
Carving tongues and dishing up	4	
Dishing up peas and carrots	1	
Total working time for the dish		24
Canned pears :		
Opening and serving	4	
Total working time for the dish		4
Total working time for cooking and serving the dinner		43
Serving		2
Shopping time		15
Total time		60

TABLE III. COST OF A SUNDAY DINNER OF FRESH OR HOME PRESERVED PRODUCTS

Tomato soup with fish-balls :		
950 g tomatoes	1.50 d.kr.	
2 litres stock or water	-	
40 g margarine	0.12 d.kr.	
50 g flour	0.05 d.kr.	
35 g onions	0.05 d.kr.	
salt and pepper	0.01 d.kr.	
300 g minced fish	0.55 d.kr.	
		2.28 d.kr.
Boiled pork tongues with stewed vegetables :		
1600 g pork tongues	8.00 d.kr.	
300 g canned peas	1.02 d.kr.	
1000 g carrots	0.98 d.kr.	
30 g margarine	0.09 d.kr.	
40 g flour	0.04 d.kr.	
salt	-	
parsley	0.10 d.kr.	
		10.23 d.kr.
Bottled pears :		
900 g bottled pears	3.06 d.kr.	
		3.06 d.kr.
Gas used		0.22 d.kr.
Total cost of dinner		15.79 d.kr.

TABLE IV. COST OF A SUNDAY DINNER OF CANNED PRODUCTS

Tomato soup with fish-balls :		
1/4 kg canned tomato puree	1.15 d.kr.	
2 litres stock or water	-	
40 g margarine	0.12 d.kr.	
50 g flour	0.05 d.kr.	
35 g onions	0.05 d.kr.	
salt and peper	0.01 d.kr.	
1/2 kg canned fish-balls	1.20 d.kr.	
		2.58 d.kr.
Boiled pork tongues with stewed peas and carrots :		
1 kg canned pork tongues	8.50 d.kr.	
1/2kg canned peas	1.25 d.kr.	
1 kg canned carrots	2.00 d.kr.	
30 g margarine	0.09 d.kr.	
40 g flour	0.04 d.kr.	
salt	-	
parsley	0.10 d.kr.	
		11.98 d.kr.
Canned pears :		
1 kg canned pears	3.60 d.kr.	
1/2kg canned pears	2.00 d.kr.	
		5.60 d.kr.
		20.16 d.kr.
Gas used		0.05 d.kr.
Total cost of dinner		20.21 d.kr.

These experiments prove that the dinner prepared with canned goods costs 4.41 danish crowns or about L 0-5-4 more than the dinner prepared from fresh materials, but by using canned goods 2 hours 52 minutes, are saved.

Furthermore, tidiness and cleanliness of the kitchen while the dinners are being cooked vary according to the materials used. When fresh food is used the kitchen is full of scraps and peelings whereas when the meal is made from canned food it remains tidy and clean.

The time saved by using canned food was evidenced by an experiment made in connection with this exhibition.

A housewife worked with a lamp fastened to the back of her hand. She prepared a dish with and without the use of tins. The housewife's movements in both cases were followed by a camera. The results are shown on the accompanying photos, where the great difference in the number of movements is clearly seen.

Fig. 1. Movements required for preparing a dish with fresh food.

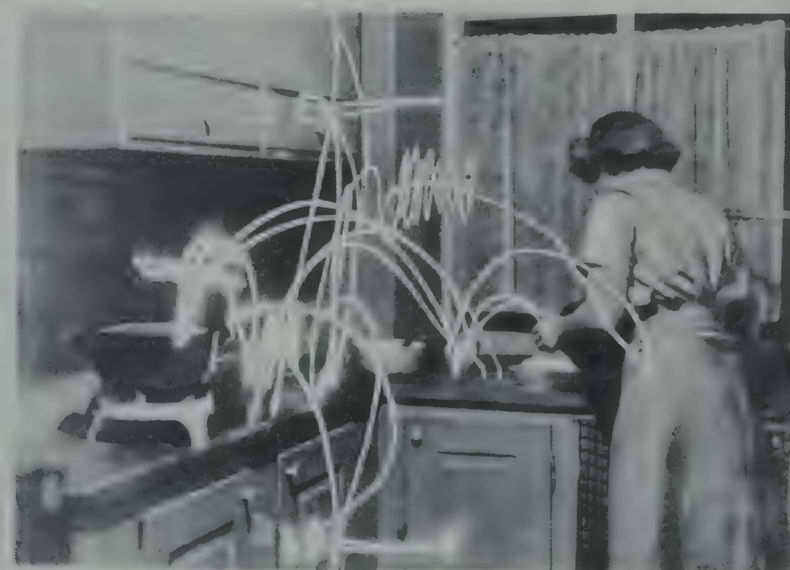

Fig. 2. Movements required for preparing the same dish with canned food.

XXX. COMPARATIVE COST AND AVAILABILITY OF CANNED, GLASSED, FROZEN, AND FRESH FRUITS AND VEGETABLES IN THE UNITED STATES OF AMERICA

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I. INTRODUCTION

The canning industry has long recognized the importance of preserving the many natural nutritive qualities of its products and has been instrumental in conducting extensive research both in evaluating nutrient losses due to canning and improving canning techniques which keep these losses at a minimum. As the result of a comprehensive and long-term research program with the two fold aim of obtaining data on the nutrients in food after canning and information on the improvement of methods and equipment leading to greater retention of nutrients, the food canning industry is in position to make the statement that (1) "We know more about the nutritional values of canned foods than is known about any other type of processed food".

Little information is at hand, however, concerning comparative cost and availability to the consumer of canned, glassed, frozen, and fresh fruits and vegetables. It is readily evident that the economic aspect of this question is worth considering since no amount of nutritional merit in a food can be of great practical significance if it has only a limited availability or if its price is comparatively high. The study (2,3) on the comparative cost and availability on the various processed foods was conducted for the purpose of making a systematic and controlled investigation of the factors of availability and cost for the most common foods packed in cans, packed in glass, fresh, and frozen.

II. METHODS

1. General

The investigation was conducted with the collaboration of nineteen schools of home economics distributed throughout the United States, as indicated on the map shown in Fig. 1, p. 2. The possible effect of such factors as population level (city size) and geographic location on the picture of availability and food cost were taken into consideration by selecting cities with population levels of over 1,000,000 (four

(1) Food Industries Staff Report : Survey shows high nutrient levels in canned foods. Food Industries 21, 92 (January), 1949.

(2) Krehl, W.A., and Cowgill, G.R., Comparative Cost and Availability of Canned, Glassed, Frozen, and Fresh Fruits and Vegetables. J. Am. Dietet. A., 24, 384, 1948.

(3) Krehl, W.A., and Cowgill, G.R., Comparative Cost and Availability of Canned, Glassed, Frozen, and Fresh Fruits and Vegetables. Continuation of study. J. Am. Dietet. A., 26, 168, 1950.

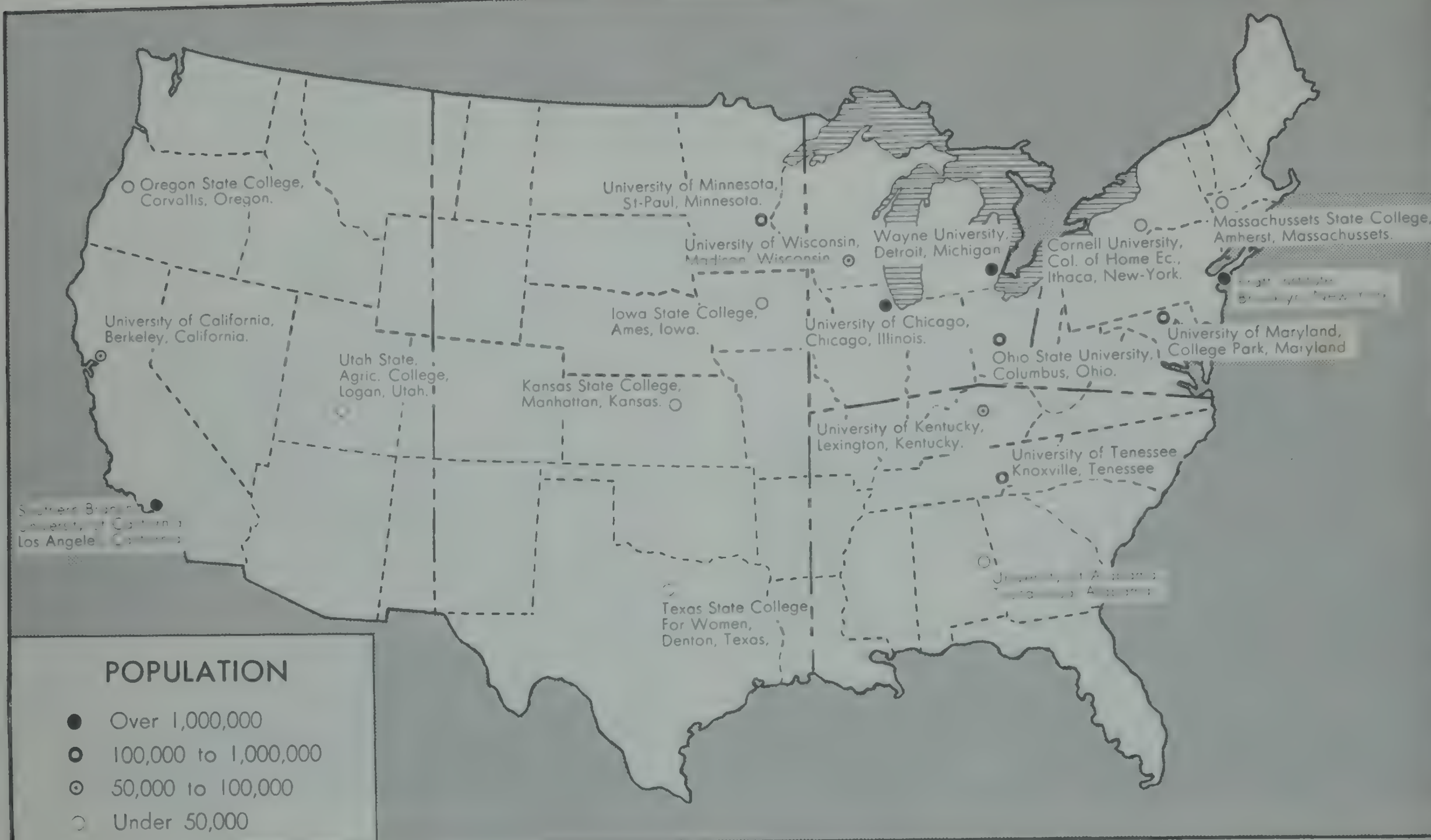

Fig. 1. Locations of cooperating institutions in food cost study.

cities), from 100,000 to 1,000,000 (four cities), from 50,000 to 100,000 (three cities), under 50,000 (eight cities), and by choosing five geographic areas (Fig.1) designated for the purpose of this study as West, West central, North Central, Northeast, and Southeast, respectively. An attempt was also made, as far as possible, to have a representative population level of the type described above in each of the indicated geographic areas.

The fruits and vegetables that were investigated are as follows : asparagus, lima beans, string beans, whole beets, whole corn kernels, peas, spinach, tomatoes, peaches (halves), pears (halves), pineapple, grapefruit juice, and in the third year of study, orange juice. The study was conducted over a three year period starting in October, 1946.

In all fairness it must be noted that certain of the foods studied, i.e., beets, tomatoes, pears, and (until recently) grapefruit juice, are not processed in the frozen form and therefore zero availability on these products cannot be viewed with prejudice. If this study had included such items as strawberries; broccoli, cauliflower, and rhubarb, the observations on their availability in cans would have been discouraging since these items are rarely, if ever, available in the retail market in canned form (Table 1). Again, as far as processed foods are concerned, it is important to note (Table 1) that these particular items are of relatively minor importance to the consumer in terms of quantity as compared to the fruits and vegetables actually chosen for this three year survey (see above).

2. Investigative procedure

During the second full week of each month the investigator visited a super-market, owned either locally or by a national chain, where the brands, grades, unit prices, and net weights of the above canned, glassed, and frozen fruits and vegetables were recorded. The customary "home size" items were priced, i.e., 16 or 20 oz. for vegetables, 29 or 30 oz. for fruits, and 18 oz. for fruit juice. Since some items were not available in the first store visited, up to two additional stores --- preferably, but not necessarily chain markets or super-markets --- were "shopped". If any item could not be found in three stores, the item was considered to be "not available", although the term "not readily available" would perhaps be more accurate. In any event, the store number, i.e., 1, 2, or 3 in appropriate order, was indicated for each item priced or purchased since these data were used in computing availability (discussed in more detail below). Each investigator was further instructed to "shop" the same stores, and when possible, price the same brands of merchandise each month for additional attempts at uniformity in securing the data.

All canned and glassed foods that were priced were, whenever possible, grade A or a well-known brand, but not a premium priced specialty. Although no grade standards are available for frozen foods, it was assumed that all frozen products were grade A ; the best known brands were selected when available.

TABLE 1 - COMPARISON OF TONNAGE OF PROCESSED FOODS IN 1947-48 AND 1946-47

FOOD	Type of Processing			
	Canned in cans or glass(1)		Frozen	
	1946 tons	1947 tons	1946 tons	1947 tons
Asparagus	57,200	47,913	14,158	5,369
Beans – Green and wax	229,275	163,638	20,488	15,451
Beans – Lima	21,835	27,550	25,047	33,789
Beets	88,050	42,275	none	none
Broccoli	none	none	12,895	4,509
Cauliflower	none	none	6,619	2,677
Corn (cut)	386,884	326,113	21,213	13,280
Grapefruit juice	72,364	48,813	none	none
Peaches	484,381	454,643	32,570	13,517
Pears	139,470	146,638	none	none
Peas	511,663	413,988	70,302	65,893
Pineapple	indeterminate(2)	indeterminate(2)	11,503	2,955
Rhubarb	none	none	5,283	769
Spinach	105,603	48,863	19,093	11,640
Strawberries	94	1,470	39,030	54,518
Tomatoes	298,213	346,363	none	none

(1) No accurate breakdown by can or glass available. Careful estimates place the total tonnage of the foods studied packed in glass at less than 1 per cent.

(2) Indeterminate because of many types of packs (juice, chunks, crushed, sliced, and so on). Figures for all categories of canned pineapple for 1947-48 are 11.429, 144 cases of pineapple and 8.893.631 cases of pineapple juice.

The cost of fresh fruits and vegetables was arrived at by actual purchase and preparation as for home cooking or canning (see below). The actual cost was determined, therefore, by relating the original cost to the final weighed edible portion. For example, if 1 lb. of fresh peas was purchased at 20 cents and final weight of edible portion was 8 oz., the actual cost of the edible portion would be 40 cents per pound.

The weights of the fresh foods purchased were carefully checked with dietetic scales to ascertain their correctness within 1 oz. per pound. This was considered necessary since, particularly with large items like asparagus and peaches, the retailer sometimes misses giving close weights. For this reason, if there was a disparity in the correct weight of the fresh material exceeding the amount stipulated above, the actual cost per pound was corrected by the following formula :

$$\frac{\text{Correct weight received (pounds)}}{\text{Cents that should have been paid}} = \frac{\text{Actual weight paid for (pounds)}}{\text{Cents actually paid}}$$

Quantities of the fresh fruits and vegetables were purchased which would be both representative and present a minimum of error in subsequent preparation and final weighing of the edible portion.

The quality of each fresh food purchased was graded as closely as possible (A, B, C and D for excellent, good, fair, and poor, respectively) based on customary home economics practice, and in all cases efforts were made to buy grade A produce.

The fresh produce was prepared as follows :

Asparagus was cleaned, washed, and the stalks trimmed to the point where they were tender;

Lima Beans and peas were removed from their shells, and all the small, imperfectly-formed beans and peas which would not be used in a grade A pack were discarted;

Corn was husked and the kernels cut from the cob, care being taken to keep the kernels as nearly whole as possible;

The ends of the string beans were clipped and any strings removed;

With beets the greens and the stalks were removed and the beets peeled with minimum waste;

Spinach was washed well, tough stalks discarded, and then air dried until the visible water had been removed.

Tomatoes were skinned by scalding and the stem ends removed. Any liquid which drained from the tomatoes during the process was included in the weight of the edible portion.

Pineapple was prepared by removing and discarding all inedible parts including the core.

The skins and stones of the peaches and the skins and cores of the pears were removed. All inedible portions of the fruit including the core were removed. To obtain grapefruit juice or orange juice, the fruit was squezzed until the "maximum" amount of juice had been extracted. The grapefruit or orange juice was then strained to remove all pulp and seeds. The final weight of the edible portion was recorded to the nearest tenth of an ounce.

In view of the fact that all fresh produce was evaluated as to final cost on the basis of the edible portion obtained, it was necessary, for complete fairness in comparisons, to make a similar and appropriate conversion for the canned, glassed, and frozen fruits and vegetables. The weight percentages of the contents (conversion factors) of cans, glass jars, or frozen packages considered to be representative of the edible portion, compared on the same basis as was used for the fresh produce, were determined by experimental checks on the values used in customary commercial canning practice. The percentages of edible portion for canned and glassed fruits and vegetables are as follows: asparagus, 70; lima beans, 68; string beans, 62; beets, 68; corn, 68; peas, 65; spinach, 72; tomatoes, 100; peaches, 66; pears, 57; pineapple, 66; and grapefruit juice, 100. For the frozen fruits and vegetables the conversion factor (per cent edible portion) was considered to be 100 for all except peaches and pineapple which were 80 and 75, respectively.

To obtain the edible portion for each food, therefore, the respective net contents of can, glass jar, or frozen package were multiplied by the appropriate conversion factor. It should be noted, however, that all of these factors for edible portion are minimal, since in actual practice the liquids or juices from the vegetables and fruits, respectively, are not discarded but are largely consumed. The reason for using these factors in presenting the comparative data on const is for the purpose of reducing everything to a common denominator, namely, the cost of the weighed edible portion in cents per pound of canned, glassed and frozen food is obtained by dividing the weight of the edible portion in pounds by the unit cost.

The problem of presenting data on availability should be reviewed for purposes of clarification both as to choice of terminology and methodology. Perhaps "availability index" as defined and used in this study would be more accurate than " availability " in the finite sense of the word. The stores selected for shopping (three in number) were, by instruction, large markets and "probably self-service", so that no customer would be given "preference treatment" on the supply of scarce merchandise. The order of shopping these stores was uniform and was chosen in the first place in the order of " housewife preference ", using such things as proximity to home, quality of produce, economy, cleanliness, and so on, as basic guides.

Since each of nineteen investigators had three stores in which to shop, the total potential number of store visits that might be made in any one shopping period to find an item would be fifty - seven. If an item could not be found by any investigator in any of the three stores visited, the item would be considered unavailable. This should not be taken to mean that it was unobtainable; it means merely that unless unusual circumstances prevail, the housewife would not be apt to shop in more than three stores for a particular item, but would select a substitute. The 100 percent availability figure was arrived at by dividing the number of " finds " by the minimum number of visits needed to " find " the item. If, for example, each of the nineteen investigators found the item in the first store visited, the availability of that item would be 19/19 x 100 or 100 percent. This does not necessarily mean that the foodstuff in question was actually available in all of the three stores that each of the nineteen investigators might have visited. Under the circumstances cited however, it is reasonable to define the item as 100 percent available because each shopper had success on the first try. Any intermediate percentage for availability or "shopping success" is obtainable, therefore, by the following formula :

$$\frac{\text{number of times an item was found}}{\text{total visits made to find the item}} \times 100$$

Such an index of availability cannot take into account all aspects of the problem since such factors as (a) number of brands of a given food available in a given store; (b) different ways that the product is packed, i.e., sliced, crushed, or chunks of pineapple; or (c) the actual number of days of the shopping year that the product is on the store shelf, and so on.

III. RESULTS AND DISCUSSION

Although the investigators carried out their shopping and pricing schedules on a monthly basis, the individual monthly data on cost and availability of the several foodstuffs investigated are deleted from the present report and the twelve month average cost and availability figures for each year are taken as representative for any one year. This again is a reflection of the observations made as the study progressed that the individual processed foods show a high degree of month - to - month stability in price and only tended to show price trends only over longer periods of time. This is particularly impressive in view of the fact that during this period, which was a general inflationary one, price increases of most merchandise were not uncommon. The general stability of prices of the processed foods is understandable however, since for the most part crops are processed each year in amounts which will accomodate normal consumer demand plus a small carryover. As might be expected, the cost of fresh foods, however, fluctuated over a greater range, and for the most part bore an inverse relationship to their availability. The data on the average cost and availability of the fruits and vegetables studied with the relative percentile changes for each foodstuff considered from year-to-year are compiled in Tables 2 and 3 respectively. It will be noted that data on cost or availability of foods processed in glass are not considered in these tables since their extremely limited availability gives this category little practical importance and presents too little data to be presented here with any degree of fairness or accuracy.

TABLE 2 - AVERAGE COST PER POUND OF EDIBLE PORTION IN CENTS
1948-49 vs. 1946-47 and 1947-48

Produce Studied	1946 - 1947			% Change			1947 - 1948			% Change			1948 - 1949		
	C	Fz	Fr[1]	C	Fz	Fr	C	Fz	Fr	C	Fz	Fr	C	Fz	Fr
Asparagus	.52	.64	.64	0	+ 9	-20	.48	.62	.59	+ 8	+13	-14	.52	.70	.51
Lima Beans	.31	.53	.65	+10	+ 8	- 9	.31	.56	.58	+10	+ 2	+ 2	.34	.57	.59
String Beans	.28	.51	.25	+14	- 8	- 4	.29	.45	.26	+10	+ 4	- 8	.32	.47	.24
Whole Beets	.21	NA	.18	+14	--	- 6	.22	NA	.17	+ 9	--	0	.24	NA	.17
Whole Corn Kernels	.24	.37	.37	+13	+ 8	- 8	.26	.38	.39	+ 4	+ 5	-13	.27	.40	.34
Peas	.26	.38	.52	0	0	+10	.26	.39	.56	0	- 3	+ 2	.26	.38	.57
Spinach	.17	.31	.22	+ 6	+ 6	+23	.16	.31	.24	+13	+ 6	+13	.18	.33	.27
Tomatoes	.16	NA	.30	0	--	- 7	.16	NA	.32	0	--	-13	.16	NA	.28
Peaches (Halves)	.27	.42	.19	0	- 5	0	.26	.40	.20	+ 4	0	- 5	.27	.40	.19
Pears (Halves)	.43	NA	.23	0	--	-13	.41	NA	.22	+ 5	--	- 9	.43	NA	.20
Pineapple	.33	.48	.32	+12	+ 2	0	.37	.44	.34	0	+11	- 6	.37	.49	.32
Grapefruit juice	.10	NA	.18				.08	NA	.18						
Orange juice													.13	.19	.22

(1) C = Canned, Fz = Frozen, Fr = Fresh.

Since the information presented in Tables 2 and 3 represents only the yearly national averages on the cost and availability of the various foods, both processed and fresh, it is interesting to present the data in the form of cost indices, based upon canned goods taken as 100, for cities of different sizes, for the different geographic areas, and for a comparison of the cold months (November through April) with the warm months (May through October). An examination of these data presented in Table 4 (page 6) indicates that remarkably similar cost relationship held between the various categories of processed food regardless of the size of city and geographic territory. If the cost indices are compared for the "cold months" and "warm months", it is evident (Table 4) that only minor fluctuations in cost existed between the warm and cold months except for foods in the fresh category which, as excepted, cost less in the warm months because of their generally greater availability. The cost of fresh foods also tends to decline as the general population of the city decreases.

TABLE 3 - AVAILABILITY IN PERCENT 1948-49 vs 1946-1947 and 1947-1948

Produce Studied	1946 - 1947			% Change 1949 over 1947			1947 - 1948			% Change 1949 over 1948			1948 - 1949		
	C	Fz	Fr[1]	C	Fz	Fr	C	Fz	Fr	C	Fz	Fr	C	Fz	Fr
Asparagus	79	58	22	+ 5	0	+32	72	57	21	+15	+ 2	+38	83	58	29
Lima Beans	43	48	17	+53	+23	-47	53	56	10	+25	+ 5	-10	66	59	9
String Beans	70	55	51	+10	+15	+12	76	55	56	+ 1	+15	+ 2	77	63	57
Whole Corn Kernels	79	58	27	+ 5	+ 9	+41	77	58	36	+ 8	+ 9	+ 6	83	63	38
Whole Beets	58	NA	57	-14	--	- 4	49	NA	53	+ 2	--	+ 4	50	NA	55
Peas	84	57	40	+10	+14	-38	86	58	30	+ 7	+12	-17	92	65	25
Spinach	85	58	48	- 5	+ 3	-10	78	56	45	+ 4	+ 7	- 4	81	60	43
Tomatoes	66	NA	68	+17	--	+24	78	NA	71	- 1	--	+18	77	NA	84
Peaches (Halves)	69	47	40	+33	+11	- 8	81	48	50	+14	+ 8	-26	92	52	37
Pears (Halves)	62	NA	46	+29	--	+17	82	NA	38	- 2	--	+42	80	NA	54
Pineapple	19	38	29	+22	-58	-14	37	23	26	+86	-30	- 4	69	16	25
Grapefruit juice	77	NA	70				72	NA	68						
Orange juice													78	51	84

(1) C = Canned, Fz = Frozen, Fr = Fresh.

It is of interest to note (Table 4) that the cost indices of the 8 foods available in the frozen form showed a downward trend from 1947-48 to 1948-49, although it is clear that the cost of frozen foods continues to be at least 50 per cent higher on the average than comparable products processed in cans. Although marked increases in the availability of both canned and frozen produce was evident during the period of study (Oct. 1946-Sept.1949), these increases were most marked in the category of canned fruits and vegetables. This is particularly evident for canned peaches, pears, and pineapple and may be explained for the most part to the combined effect of increased supplies of sugar and cans during the period investigated. Return to near normal shipping facilities from Hawaï to the United States during 1947-48 helps to explain the greatly increased availability of pineapple during this period. The general availability of canned foods was greater than frozen, while frozen foods were more available than fresh, for the most part.

Of special interest, is the figure of 51 percent on the availability of orange juice concentrate, frozen in cans for the year 1948-49 (Table 3, page 5). It must be pointed out that this figure is a yearly average and does not reflect the true availability and general public acceptance of this product. An examination of the monthly figures from October 1948 through September 1949 reveals monthly percent availabilities as follows : 33, 25, 37, 43, 43, 48, 57, 57, 59, 61, 73, 73. It is anticipated that further study would show near 100 percent availability for this product.

The cost of both canned and frozen foods fluctuated very little and showed only minor price trends over long periods of time. To illustrate, the maximum price increase over a three year period for canned foods was 14 percent for string beans and whole beets and most of the rest of the foods in the canned category showed a price increase of about 10 percent. About the same range of price increases helds for the frozen and fresh fruits (Table 2, page 5). The cost of fresh foods averaged about 27 percent higher than canned foods in the cold months from November through April while the cost of fresh foods was similar to canned for the warm months, May through October (Table 4).

TABLE 4 - COST INDICES FOR 1947-48 AND 1948-49 FOR FRESH AND FROZEN FOODS ACCORDING TO SIZE OF CITY AND GEOGRAPHIC AREA, USING INDEX FOR CANNED FOODS AS 100

CITY SIZE AND REGION	AVERAGE INDEX											
	8 Frozen Foods						12 Fresh Foods					
	12 months		Cold Months (1)		Warm Months (2)		12 months		Cold Months (1)		Warm Months (2)	
Size of City	1947-1948	1948-1949	1947-1948	1948-1949	1947-1948	1948-1949	1947-1948	1948-1949	1947-1948	1948-1949	1947-1948	1948-1949
Over 1 million	160	150	159	150	162	151	130	109	141	116	120	101
100,000 to 1 million	161	153	169	156	166	149	126	120	132	146	112	101
50,000 to 100,000	164	151	158	158	171	145	115	101	113	112	105	93
Under 50,000	161	149	164	150	161	150	115	114	118	137	105	98
Geographic Area												
Northeast	155	152	163	151	157	154	120	105	123	125	112	90
Southeast	153	150	169	151	162	149	120	121	127	139	109	109
North Central	159	157	161	157	174	156	142	123	141	144	127	107
West Central	163	148	162	148	160	149	101	111	102	123	96	110
West	161	142	159	145	163	139	119	106	132	118	101	95
NATIONAL AVERAGE			162	152	164	150			135	127	115	101

(1) November through April

(2) May through October

IV. SUMMARY

A nation-wide survey of the cost and availability of canned, glassed, frozen, and fresh fruits and vegetables has been conducted for a three year period.

Although both canned and frozen foods showed price stability with only minor trends upward during the study, canned foods in general averaged 50 percent less in cost than frozen foods and, furthermore, were in general more available.

From the standpoint of what the dollar can purchase, there is no doubt that of the fruits and vegetables studied, canned foods offer the most nutritional value.

XXXI. COMPARATIVE COST AND AVAILABILITY OF PRESERVED AND FRESH FOODS

by G. JUMEL

Conseiller technique, Conseil supérieur de la Conserve (France)

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I. INTRODUCTION

A few centuries ago, when our sailors making long voyages to distant lands solved their food problems by storing the very first smoked fish in their ships, no one thought of the comparative cost of fresh and cured fish, nor of their respective availability.

When the pioneers of the canning industry developed the first food preservation processes, - empirically at the outset and later on scientifically, - their discoveries certainly revolutionized methods of nutrition, but their studies and research were undertaken for the sole purpose of avoiding wastage of perishable goods and of permitting deferred consumption of certain foods in places or at times when it was impossible to obtain supplies of fresh foods, and they would probably have been surprised to learn that at this 2nd Congress on Canned Foods we are interested in comparing reserved foods with the original products from an economic standpoint.

The very fact that such a comparison is now possible is evidence of our technical and social progress. It is to the credit of manufacturers that they have constantly modernized their means of production and made a study of all possibilities of bringing down their costs, so as to expand their business, increase their sales and contribute more efficiently to feeding mankind.

But this possibility is also due to the evolution of our style and standard of living which controlled it and made it imperative. The rise and development of great cities, the increasingly rapid tempo of daily life, the necessity for collective work by those who formerly devoted all their time and effort to the preparation of family meals are also determining causes of the consumption of preserved foods which are daily becoming more numerous and more varied.

Only a short time ago preserved foods were still reserved for certain special cases, such as the needs of explorers of unknown lands, of navigators, of men in the armed forces, and recent events have shown us that the same demands exist to-day; but it is also true that the consumption of preserved foods nowadays is customary throughout the population of France.

It is advisedly that I say "the population of France", for although I am able to study this problem in other countries and, in particular, those in which this industry has developed to a considerable extent, I shall only speak now of products of French manufacture and of the economic problems peculiar to our country.

II. A SURVEY OF THE FRENCH INDUSTRY FROM THE ECONOMIC VIEWPOINT

It is henceforth possible from the economic standpoint to compare fresh and preserved products, but a comparison can only be made if the products themselves are comparable. What I mean is this :

Numerous historical, scientific or biographical studies have brought out the importance of the production of canned fish in oil. I am purposely refraining from comparing - as to availability - fish canned in oil with that freshly netted by the fishermen of our coasts and put down, packed in ice, on the quayside of our ports. The preparation of canned fish, its grilling and processing in oil bring about substantial changes in the original product, and equivalent processes cannot possibly be carried out either by housewives or even by community caterers.

I am tempted to say the same of fish canned in the natural state, but the problem here is slightly different. It is not impossible for a housewife to prepare products of this kind in the same form as that

in which they are produced by canners, but she would certainly not be tempted to do so frequently and as a matter of course. Fillets of mackerel and tunny fish are marketed in pre-fabricated form (if you will allow me to coin this expression) and it is not the money factor, but that of time and skill which is involved. Canned tunny fish "au naturel" cannot be compared with a piece of tunny prepared in the home or in a hotel kitchen; the canned product is trimmed and entirely edible, so no comparison is possible.

The case of specialities in canned sea food is very similar to that of dishes prepared with canned vegetables or fruit, on which I also want to say a few words.

In this connection, I would like to remind you that a French fruit or vegetable canner's turnover is in many cases dependent on his seasonal purchases of green peas. This may seem a commonplace, but the fact is of importance for the subject under consideration, for it is in the field of "vegetables only" that the comparison which is the object of this study can be made without any outside considerations, and this is why the figures I shall mention in this paper often refer to this particular kind of canned food.

In connection with canned garden produce, the case of tomatoes is especially significant. In spite of being subject to price variations which are particularly dangerous for the manufacturers concerned and which are due to fluctuations in market rates, this industry furnishes a most convincing argument in support of the preserved product. Whatever may be the date and the price at which it is put on the market, - even in the production season, - canned tomato, whatever its degree of concentration, is a basic item of French food and tomato purée is consumed all the year round in France.

Only a short time ago, canned fruit was a luxury and few were the households which could afford to include pears in syrup, or even apricots packed in water in an ordinary meal. But at the present time, costs are such that their consumption is rapidly increasing from year to year, and the production of canned fruit in syrup is one of the most important industries in the economic field in many parts of our country.

As to jams, these cannot be directly compared with fresh fruit, but only with home preparations or those produced on a small scale by artisans. The French housewife made all her own jam from recipes handed down from one generation to the other or from local recipes, when industry put a stop to, or caused a considerable decrease in the consumption of home-made jam. To-day it can be asserted, with the support of figures, that the cost of factory-made jam and its quality, definitely better than that or the home product, will gradually entirely or almost entirely eliminate the latter. Home-made jam is practically a thing of the past and the row of jars arranged on the high dressers of country kitchens will soon be no more than a dim memory which authors will mention with a sign for bye-gone days. Slumps in the jam-making industry are not the result of cost but are due to other transient causes mainly dependent on fashion.

Other considerations govern the case of canned meat. I have just mentioned the ancestral preparation of home-made jam, and a similar situation exists in connection with the old-time smoking of ham in our country districts and other regional preparations which are still remembered by gourmets and epicures. Salting and curing is the object of a particularly flourishing industry and the names of a few large French firms are well known far beyond our frontiers as synonyms of taste and quality. Anyhow, salting and curing is now carried on in France almost entirely on the industrial plane and no comparison can be made with fresh products.

The last products to be considered are canned " prepared dishes ". These are specifically French products the reputation of which is not only due to manufacturing methods, up-to-date equipement, productivity, but also to the culinary and gastronomic capacities of their makers. There is no sense in comparing such factory-prepared products with fresh products unless the comparison bears on the skill of the cooks employed in large industrial concerns and that of an average French cook. Here also we must discriminate between preparations which can be produced on the individual plane and those which can only be produced on the industrial plane.

III. COST

An efficient study of the cost and availability of preserved foods can only be made if attention is given to factory costs and if a careful examination is made not only of the various items and their relative repercussion on the sale price to consumers, but also of their evolution during the last few years.

This is a difficult task, but an essential one for determining the economic position of French manufacturers and for making reliable comparisons of preserved and fresh products.

In this connection I shall refer to the work done by Mr. BIRMAN, whose competence and talent are well known to readers of "l'Officiel de la Conserve", as I consider that his methods of calculating industrial and commercial costs are the most convenient ones; indeed, the distinction he makes between the two main items enables a manufacturer to realise at any time how his business is operating and an economist to have a correct knowledge of the situation of our various industries.

The industrial cost exclusively covers purchases of raw materials and accessory products and expenses connected directly or indirectly with processing (labour, power, etc...).

The commercial cost is the industrial cost plus a proportion of the business expenses other than processing costs.

I must add that these costs can only be approximate. The seasonal character of our industries, the various degrees to which their equipment and plant have been modernised, their geographic situation, their diversified production or their specialisation in one clearly defined branch, make it impossible to attempt to work out any accurate estimate. And in fact this is why the Public Authorities found it so difficult to establish any collective cost price in periods of shortage.

I have selected the following examples because I consider them the most significant in our French industry; they are the average prices practised in the growing season and calculated by the professional associations; the reference years are those which, in my opinion, can give information of a general order, their choice being limited by contingencies of crops or fish catches.

I am purposely limiting these examples to three - sardines canned in oil, canned peas and jams.

st example : sardines canned in oil

This case is not very significant for comparison with the fresh products, as I have already said, but it is very instructive on account of the importance of this production in French industry.

TABLE I	1939		1950		
	Price in francs	%	Price in francs	%	Index
Raw materials :					
Fishes	79.64	22.30	1,804	18.10	22.6
Oil for frying	3.75	) 6.86	200	) 10.77	43.8
Covering oil	20.76	)	873	)	
Salt	1.33	0.38	16	0.16	12.0
Packaging :					
Lithographed cans, cases	53.41	14.98	925	9.28	17.3
Manufacturing expenses:					
Labour	28.21	7.90	521	5.23	18.5
Social charges	4.29	1.17	213	2.13	49.6
Coal, electricity ...	3.17	0.89	97	0.97	30.6
O.S.T.P.M.(+) control ..	-	-	10	-	-
Gross cost price :	194.56		4,659		
Overhead expenses ...	29.20	)	863	)	
Profit	9.73	) 15.44	288	) 15.06	27.1
Selling expenses	37.22	)	1,380	)	
Price ex factory :	270.71		7,190		
Wholesaler's margin of profit	26.79	-	776.72	-	-
Taxes	3.--	-	204.28	-	-
Price to retailers :	300.50		8,171.--		
Retailer's margin of profit	53.10	-	1,544.90	-	-
Taxes	3.53	-	249.10	-	-
Total of margins of profit	-	22.38	-	23.30	29.0
Total of taxes	-	7.70	-	15.00	54.3
Price to consumer	357.13	100 %	9,965.--	100 %	27.9

(+) Office scientifique et technique des Pêches maritimes.

The calculations have been made for 100 1/4 club 30 cans (130 ml each), and table I shows all the items of this manufacture; the comparison was made between 1939 and 1950.

In 1939 peanut oil was quoted at Frs. 4.60 per kilo; in 1950 its price was Frs. 194.-.

The average wage taken for 1939 is frs. 3.526 per hour, plus 15.20 % for social charges, made up as follows :

- Social insurance ...... 4 %
- Family allowances ..... 5.50 %
- Apprenticeship tax 0.20
- Employer's liability ins. 1.50
- Holidays with pay 4.--

15.20 %

The average hourly wage taken for 1950 is Frs. 65.18, plus 40.77 % for social charges, made up as follows :

- Social security .... 10 %
- Family allowances ..... 16 %
- Apprenticeship tax 0.40
- Employer's liability .. 2.34
- Holidays with pay 4.65
- Medico-social service . 0.75
- Mothers'holidays 0.35
- Incidence on holidays with pay 1.25

35.77 %

- Tax on salaries 5.--

40.77 %

Overhead expenses (operation and administrative) and profit have been taken at 10.80 % and 3.60 % respectively; selling costs are made up as follows :

- Single tax .... 6.75 %
- Armament tax 1.--
- Agios and bank charges. 1.--
- Manufacturing risks ... 1.--
- Commissions and considerations 4.--

13.75 %

For the year 1950, overhead expenses and profits have been taken at 12 % and 4 % respectively, the selling costs being made up as follows :

	13.50 %
Tax on production	1.-- %
Tax on transactions	4.-- %
Commissions to representatives	2.-- %
Agios and bank charges	1.-- %
Manufacturing risks	0.20 %
Professional subscriptions	

2nd example : canned peas

The details given in the previous example apply to other activities as well so that we can shorten the explanations concerning canned vegetables. Table II hereafter gives all necessary information regarding the cost of the manufacture of canned peas; the comparison is made between the years 1938 and 1948.

TABLE II								
Description	1938				1948			
	Amount in francs		%		Amount in francs		%	
Raw materials :								
Price of peas in pod	115				1,700			
Vegetables for 100 cans (+)	176		38.22		3,680		39	
Seasoning	5.40		1.18		20		0.20	
Packages and waste	105		22.80		1,950		20.70	
	--------	286.40	-------	62.20	---------	5,650	-------	59.90
Manufacturing expenses :								
Direct wages	18.85		4.08		400		4.10	
Social charges	2.30		0.49		175		1.90	
Consumable materials	9.35		2.03		175		1.90	
	--------	30.50	-------	6.60	---------	750	-------	7.90
Industrial cost price :		316.90		68.80		6,400		67.80
Overhead expenses	60.25	60.25	13.10	13.10	944	944	10.--	10.--
Selling expenses :								
Tax on production	28.09		6.10		944		10.--	
Armament tax or tax on transactions	4.60		1.--		94.40		1.--	
Commission to representatives ..	13.80		3.--		283.30		3.--	
Agios and bank charges	9.20		2.--		188.90		2.--	
Conservation risks	4.60		1.--		188.90		2.--	
Professional dues	-		-		18.90		0.20	
	--------	60.30	-------	13.10	----------	1,718.40	-------	18.20
Profit :		23.05		5.--		377.60		4.--
SALE PRICE		460.50		100 %		9,440.--		100 %

(+) 1/1 cans, 850 ml each.

3 rd example : Jams

The calculations have been made for the can known as 1/1 (pure sugar and fruit) and the comparison applies to 1939 and 1949, when the French Ministry of National Economy stopped rationing jams and created a system of price control. Table III hereafter gives all necessay information regarding this manufacture.

TABLE III				
Description	1939		1949	
Raw materials Manufacturing expenses		8.89		154.52
Selling expenses	Single tax .... 9% Tax on transactions.. 1% Financing .... 1% Commercial expenses.. 8% Profit 5%	2.91	Commission to representative .... 3.96% Sundry risks .... 1.--% Financing .... 1.50% Profit margin .... 2.--% Taxes on production and transactions 13.50%	43.48
PRICE EX FACTORY		11.80		198.--

General remarks

It is most interesting to compare the rises recorded since 1938 in the prices of canned and fresh products : from 1938 to 1947, fresh products increased more noticeably than canned products; for instance, in 1947, fresh peas were at the coefficient 13.3 compared with 1938, whereas canned peas were only at 12.3. Similar examples can be found in the facing table.

Products	Fresh	Canned
Peas	13.3	12.3
French beans	11.5	9.4
Asparagus	13.0	9.0
Tomatoes	15.0	11.7
Apricots	14.4	11.4
Greengages	10.0	7.8
Mirabelles	13.5	9.8

We must point out that the main reason for this increase can be found in the considerable rise in the prices of raw materials, as is clearly shown by the comparison between the cost of fresh products and the market price of the canned products taken as examples; another important factor is the continuous rise in taxes and expenses connected with deferred salaries.

The following table gives a comparison between the cost of fresh products and the market price of some characteristic canned products in 1938 and 1948 respectively.

Columns (1) show the cost of a kilogram of fresh product delivered at the factory; columns (2) show the average selling price of one kilogram (net weight) of goods taken at the factory.

Products	1938		1948	
	1	2	1	2
Peas (medium)	1.20	4.60	16	56
French beans (medium) ...	2	5.50	23	52
Asparagus (large)	3	12	39	110
Tomatoes (30 % concentrate)	0.30	7	4.50	82
Apricot pulp	2.50	5	36	61.40
Greengage pulp	2.50	6.25	25	48.60
Mirabelle pulp	2	5.25	27	51.20

Experiments have been made in order to contrast the expenses concerning canned food products compared to the corresponding fresh products.

It is possible to compose complete meals with canned foods and the result proves that canned products are much more economical : we have organised spectacular meals which brought us to the above conclusion : I refer in particular to the efforts and achievements of the Intendant of the Palais d'Orsay Hotel in Paris.

The most convincing experiments were made in Paris at the Hotel Industry Training College, under the supervision of Monsieur Albert RENAULT, first chef and teacher at the college. As early as 1938, the results of such experiments were published by O.T.U.A.(+) in a booklet devoted to the rational use of canned foods. The same examples were quoted in 1951 and though the proportions are different, the results bring out the same advantages as before.

In the case of " cassoulet ", chosen for the variety of products which enter into its preparation even more than for its reputation as local dish, the saving in 1938 worked out at 15.20 F. compared with 210 F. in 1951; this represents the index 13.82, whereas the canned dish and the dish prepared with fresh products represent the indices 29.85 and 20.20 respectively.

We could give numerous examples illustrating these facts, but we must not forget that a well-founded opinion can be obtained only by a study of the average diet of an individual or a group of individuals, in the course of a year.

IV. TENTATIVE CONCLUSION

At the end of this short study, I should like to draw a simple conclusion.

A comparison between the cost and availability of canned and fresh products cannot be provided only by figures; the proportion of fresh and canned products consumed by the French varies according to their way of living, the place where they live, the season of the year. In a study of the average diet of the Western peoples, to which this Congress is contributing on a large scale, it is easy to note that the consumption of canned products follows the evolution of modern life and that a young and vigorous nation, which has covered in an extremely short time the successive stages of political economy followed by the Old World, consumes and consequently produces or imports greater quantities of canned foods than France; it would be more difficult to give precise figures and scientific statistics.

At the moment, canned foods are and remain an auxiliary which may become essential in unsettled periods and for the more active part of the population. Nevertheless they are gradually becoming more and more essential in every day life.

I will give an example to show what I mean : considering the fishing seasons and the different species sold on the market in the course of a year, the supply of fish is comparatively even; on the contrary, the supplies of fresh fruit are limited to a few months; the National Economic Council has recently brought out a calendar of consumption of fresh fruit by the average Frenchman. On the other hand, the consumption of fruit preserved in syrup is spread over a much longer period and it is a fact that at Xmas, the consumer who will buy apricots in syrup will find them more expensive than during the production season if he cares at this

(+) Office Technique pour l'Utilisation de l'Acier, Paris.

time to make the necessary preparation; the same remark applies to vegetables with nevertheless an amusing detail : The Manager of a particularly large chain store food business told me recently, when I consulted him with a view to this Congress, that the maximum sales of canned peas correspond to the season when fresh peas are available.

The figures I have quoted and the arguments I have submitted show that the cost of canned products compares favourably with the prices of fresh products. There are a few exceptions, and the list I have given cannot be considered complete.

Even without considering the other various advantages of canned food such as hygiene, handiness, and so on, advantages which we do not need to point out to specialists, we can say that the expenses they represent for the housewife or the intendant of a collectivity are no higher than the corresponding expenses arising from the purchase of fresh products in the course of a year.

This result is not surprising if we remember the fundamental principles of food evolution : it has been obtained and can be improved only by the constant efforts of the industries concerned.

XXXII. THE COST AND AVAILABILITY OF INDUSTRIAL FOOD PRODUCTS AS COMPARED WITH HOME MADE PRODUCTS, IN SWEDEN

by Mrs C. BOALT, F. M., Direktor, Hemmens Forskninginstitut

and

GENERAL PRINCIPLES FOR COMPARING PROCESSED FOODS WITH SIMILAR HOME PREPARED DISHES

by G. BORGSTRÖM, D. Sc., Direktor, Swenska Instituted for Konserveringforstning (Sweden)

THE COST AND AVAILABILITY OF INDUSTRIAL FOOD PRODUCTS AS COMPARED WITH HOME MADE PRODUCTS, IN SWEDEN

During recent years the Swedish food industry has been steadily increasing the range of manufactured products for consumption in the home after little preparation. New methods of manufacture have been adopted and new types or primary materials included.

The aim has been partly to preserve the foods for transport and storage, and to a great extent, to undertake the preparation and the cooking of food and so render them suitable for immediate consumption.

The households of today are offered a wide selection of hermetically sealed, dried, deep-frozen or otherwise prepared products. In spite of this, the consumption in Swedish homes of semi - or wholly - prepared foods is as yet relatively small. A study of the figures for 1940 and 1950 taken from the consumption-surveys carried out by the Ministry for Social Affairs of households in towns and municipalities shows, however , that the purchased quantity of "ready-to-eat" food has increased by 20 %. This figure includes meat products, all kinds of preserves and ready-to-serve preserved dishes.

The part played by this group of products in all food costs was in each case 7 %. It is of particular interest to notice the development in the use of fruit and berry preserves. Of the household consumption of preserved fruits in 1940, 3 % was bought ready preserved, and in 1950, 14 %. It seems likely that a large number of households will continue the tendency to increase this demand for preserved food and to a corresponding degree reduce the time spent in cooking. This mainly concerns small households and others, where the housewives go out to work, the number of whom is about 40 % in the larger Swedish cities of today. In other groups of households, e.g. those consisting of large families with many children, where labour within the home itself is presumably always available, mechanisation and higher efficiency in cooking are extensively aimed at. Increasing efficiency in housework on one hand, and in industrial production on the other, are at present competitive, and it is dangerous to forecast which of these trends will take the lead.

This development should be governed by household needs and wishes, and industrial production be based on them. The Household Research Institute is following this development in collaboration with the State Institute for Public Health in Stockholm and with the Institute for Food Preservation Research, Gothenburg. The Household Research Institute considers it to be its most important task in this field to judge as to the benefit of the different products in the household : what types of ready-to-serve and semi-prepared products does the household need most ? What time - saving can the household achieve ? How can the various products be used ? How much do they actually cost compared with home-made products ?

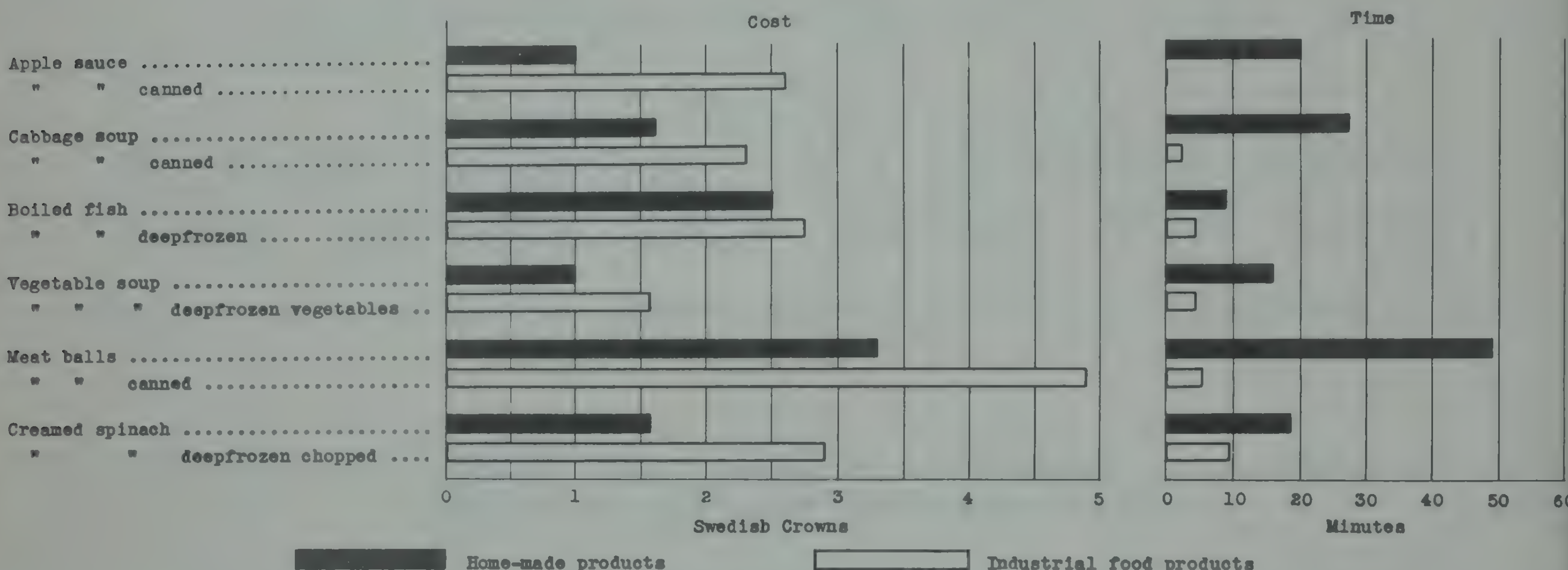
Household costs include :

1) time spent on shopping, preparation and cooking;
2) the procuring of raw materials;
3) equipment and utensils;
4) fuel and lighting;
5) storage.

These costs have been studied separately for different products and comparison has been made with industrial products processed to different levels of readiness. Vacuum-dried, frozen, hermetically sealed (semi-sterilized or completely sterilized) food products have been studied, and ready-prepared dishes on direct sale unpackaged. Certain household costs can be fairly easily estimated or calculated, e.g. time wastage cost of equipment and fuel. On the other hand, it is very difficult to put into figures the advantage the household enjoys through the levelling out of the supply of foods which industrial production creates. This factor plays an important part in Sweden. The availability of goods varies in different parts of Sweden owing to prevailing regional conditions, and the fact that distribution of fresh products can only with difficulty be organized to cover the various districts evenly. Seasonal variations are particularly wide in the case

of fruit and vegetables, which are only available during a short period of the year. Imports, however, modify this seasonal limitation in respect to certain foods - such as tomatoes and cauliflower.

Examples from comparisons between home-made and manufactured products are given in diagram (below), in which certain dishes have been selected from various groups of untreated foods such as meat, fish, vegetables, fruit, berries and mixed products like soups. The comparison is based on retail prices in Stockholm in the spring of 1951 and studies of time spent in cooking (including preparation and dressing) fuel consumption and the cost of the untreated foods for a household of 5 people.



The products which in present-day Sweden prove to be particularly profitable to buy are the following :

Meat products

Certain hermetically - sealed preserves of pure meat, such as corned beef. In contrast, ready-to-serve dishes like stewed beef, are expensive.

Fish preserves

Deep frozen fillets of fish, minced fish, mackerel and tunny fish (hermetically sealed). In contrast, the Swedish herring preserves are, for the present, very costly.

Green and root vegetables

Deep-frozen spinach, tinned peas, beans and green cabbage. In contrast, the cheaper vegetables and those easily obtainable throughout the year, such as carrots, beetroots, etc.., are very expensive.

Fruit and berries

Apple sauce, fruit syrup made from e.g. black currants, and rose-hip purée. In contrast, products easily preserved in the home, such as lingonsylt (red whortleberry jam) etc.., are expensive to buy.

Soups and other preserves

The making of soups has been greatly developed. Certain dried products such as Jerusalem artichoke purée have been made well and inexpensively. Among tinned products it has been possible to make tomato soup quite satisfactorily.

The comparison cannot, unfortunately, be extended to include quality, taste and nutritional value as between the home - made products and manufactured foods. So far, the Swedish food industry has only to a limited extent been able to avail itself of the possibilities that industrial production should be able to give to the production of foods which are superior in taste to those made at home. The Swedish food industry, however, is striving for better quality and lower prices which will increase the demand from an increasing number of households.

GENERAL PRINCIPLES FOR COMPARING PROCESSED FOODS WITH SIMILAR HOME PREPARED DISHES

It is of paramount importance that certain general principles for the discussion of the cost and the availability of canned foods compared to home prepared foods be laid down. Otherwise the study of this vital matter might easily lose itself into the wide and vast fields of economy and nutrition in general. In order to facilitate a uniform comparison an effort must be made to establish certain general principles.

In comparing the cost of fresh products with industrially prepared goods, a reasonable basis must be chosen. Sometimes a fresh product is directly compared to a preserved one, without allowing for the fact that the industrial product has been prepared, may be cut, sliced and packed. It has also been cleaned. Even in this case, processed foods are not always more expensive than fresh, due to the high distribution costs for fresh products compared to those of canned goods. But any reasonable comparison must naturally be between identical products - at the time of consumption. This implies that to the costs for the preserved product, whether canned, frozen or salted, should be added the costs for preparing the finished meal.

Another method is to refer all costs to the original amount of primary material - at the same time to the final weighed edible portion. In order to ensure an entirely fair comparison, a similar revaluation must be made for preserved products.

The percentages of edible portions of canned and glassed fruits and vegetables must be established. To obtain the edible portion for each food, the respective net contents of the package (whether can, glass or frozen package) must be multiplied by an appropriate conversion factor. Consequently the common denominator for such a comparison is the weighed edible portion of fresh produce.

The second important basis for a comparison is the nutritional value. Even when a product seems to be identical as a finished dish, its dietetic value may be different when made from fresh, newly bought products, than when it consists of a ready-to-serve preserved product. The dominant opinion is that the freshly prepared dish is always superior. Nutritional investigations have proved this is not even the case normally. This point should be studied further in most countries and greater attention should be given it in legislation and nutritional education.

Matching dishes along this particular line is complicated by the fact that the original raw material may differ widely in nutritional value. One method of comparison is to establish the degree of retention or percentage losses of various essential nutrients and relate them to the original values, irrespective, of their numerical value. This gives an idea of how processing compares with home cooking. But, if samples of cans are bought or ordered from a factory and comparative analyses performed on similar dishes prepared from products, bought locally, it may well occur that two varieties of fruits or vegetables differing widely as to their original content of ascorbic acid or some other nutrient are compared. This gives a completely false and misleading picture. I think it may safely be concluded that a correct comparison in this case can be organized only by a research institute in close collaboration with the processing industries. In this connection it should be particularly emphasized that the modern trend definitely points to a varietal differentiation. Some varieties of fruits and vegetables are particularly suitable for processing while others are better adopted for distribution in the fresh state. This example shows how extremely complicated a true comparison of food handling methods is in fact. It is most essential that research institutes plan studies in this field, paying due attention to all circumstances in order to be able to present a solid basis for nutritional education and consumer information.

In some cases canned products will never be exactly comparable to a dish prepared from fresh or raw food in the home. In other cases, the processed dish is slightly modified due to technological necessities. This does not necessarily mean a nutritional deficiency, but sometimes a difference in taste. This is particularly true of canned goods which in all cases have to be cooked during the sterilization process.

Canned evaporated milk as well as dried milk manufactured from surplus production in the spring and summer, is a product which, when made up with water to the original volume, may actually be more nutritious than some fresh winter milks. Fruit juice industries located in the growing regions are able to harvest the products when they are of maximum nutritional value. This explains why U.S. orange juice concentrates, when diluted with water, offer the consumer a beverage richer in ascorbic acid than similar juices prepared from newly bought fresh oranges. Canned fruits and vegetables manufactured at the peak of production are, due to the rich summer sunshine; far superior in vitamine C content, as compared to fresh products grown in the off-season, either in greenhouses or when there is less sunshine.

How can allowance be made for all these circumstances when comparing dishes prepared from processed foods and those made in the home? The most essential basis is that all products which are compared must be nutritionally equivalent. In this connection it is probable that many practices in general food distribution and in home cooking are seriously detrimental to the nutritional value of the products, while modern canning practice gives better guarantees of certain minimum values of essential components. Even when a product prepared in the home is identical with an industrial product, it may not equal it from the nutritive point of view. In other cases industrial products are inferior, although in this latter case there are far greater facilities for providing a uniform, high quality product. For the discussion of cost and availability, the basis should be comparison of nutritional value. This is not yet possible in most countries, due to the lack of surveys of this kind. But such studies are cardinal to the promotion of public health.

The next fundamental point in making this comparison is to see that, above all products are compared in the same stage of preparation, in other words, at the moment when they are actually consumed. From the scientific and even the practical point of view, it might be of interest to compare a thoroughly fresh product in the raw stage with a cooked product industrially canned. This, however is largely outside the scope of this particular discussion, when an industrial product has to be compared with exactly the same product prepared in the home, in order to give a fair and reasonable basis for determining their relative nutritional value. Very few papers give really comparative figures for the nutritive content of the same foods raw, cooked or canned.

Consequently, the nutritive evaluation should always be based on the food as consumed and not as purchased. It is important, therefore, to know exactly the losses of unstable nutrients which occur in the

ordinary manipulations of cooking and standing after cooking, the extent to which they occur in the liquors of processed foods, the best way of using these liquors, etc...

Ascorbic acid is retained to a considerable degree in the canning of most vegetables and fruits. In fact processed canned foods compare favourably with similar foods purchased on the market where they have lost a considerable part of their nutritive value in the course of marketing and the ordinary process of preparation in the home.

The seasonal aspect of a comparison between fresh and processed foods is certainly most vital to modern life. Some elucidatory method of measuring availability remains to be found. In addition to the aim of producing a food which retains the maximum nutritive value of the natural product, there is the essential advantage of making important nutritive components available throughout the year irrespective of seasons. This has most profound repercussion on marketing and no less a degree on actual production.

For a completely balanced comparison, several items are often overlooked, among which the following may be mentioned :

1. the additional cost of more frequent shopping unavoidable when fresh or raw products are relied on;
2. the time and cost involved in cleaning various utensils needed for home cooking from fresh ingredients;
3. the time and cost involved, in disposing of the waste parts of fresh products. This must be compared with the cost of disposing of tins or other packings;
4. the interest on the capital investment to be made in the home for specific equipment necessary for cooking or preparing various dishes.

European food technology has an important task here in inducing chemists and nutritionists in all countries to collect a broad mass of data in this particular respect and present it correctly to the public. This is not only an important educational task - it is also a fundamental basis for introducing less wasteful methods of food marketing and improving methods of home preparation to make them less costly. It is to be expected that ample information properly presented will complete public confidence which is already gradually being engendered. Processed goods are certainly destined to play a move important part in the utilization of food.

Not the least important aspect of this question is that of food hygiene. Thanks to modern techniques the risk of infection and contamination is far greater in the case of raw and cooked food than in that of canned foods. Once the tin has been opened there are naturally no longer any important differences in this respect. But from the point of view of public health it is certainly an important advantage to be able to rely on canned foods, which guarantee safer methods of distribution involving far less risks. Indirectly this has also great economic advantages both for society at large and for the individual. A comprehensive survey of statistical data from various countries would be a most valuable contribution to a sound comparison between canned foods and home prepared dishes. The collection of such information would be an important task for C.I.P.C.

The chief advantage of processed foods is the prolonged storage life which is of particular importance to the food trade. The extremely long periods, amounting to years, during which canned food can remain in good condition are demonstrated by interesting studies in the U.S. and in Europe. Changes in processed packaged and preserved foods are pratically negligeable as compared with the profound and often rapid transformation which occurs in the tissues of fresh products. Wastage and loss in these cases reach high values.

This long storage life is an important advantage, both for public health and for rational food planning on an economic basis. When comparing costs in this respect, storage costs of canned foods must be set side by side with distribution costs of fresh products, particularly when they can be obtained from all the year round seasonal markets in different regions. Most of these foods are bulky and perishable. In many cases marketing costs are extremely high and only a small part of the price paid by consumer reaches the producer. An expensive distribution organization may be a misuse of man-power and be detrimental to production - even when prices are acceptable.

XXXIII. THE BACTERIOLOGY OF SEMI-STERILE FISH PRESERVES, ESPECIALLY "GAFFELBITER" AND "ANCHOVIES"

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I. INTRODUCTION

In the Norwegian canning industry a certain class of products, the so-called spiced and pickled herring and " anchovies " preserves, constitute an important item. The manufacture of these products dates back as far as to 1841, when the first canning factory was established, principally for the manufacture of "anchovies". The brisling or sprat (Clupea sprattus) mostly used as raw material for this product were salt cured and sold in wooden kegs. Since that time the production of these herring and " anchovies " preserves has extended and kept its position in the canning industry side by side with ordinary heat processed canned foods, which are sterile preserves. The following figures, published in the latest Norwegian official statistics for the years 1947, 1948 and 1949, show the present extent of this herring and "anchovies" preserve industry :

Kind of product	Packing material	Tons			Value in N. crowns		
		1947	1948	1949	1947	1948	1949
"Gaffelbiter"	cans	1,943	1,887	1,603	7,498,368	8,523,614	7,079,694
"Anchovies"	"	1,093	1,174	1,397	2,942,577	3,841,314	4,041,218
"	kegs	294	939	52	528,658	1,876,720	73,594
"Appetite" herring	cans	154	192	463	485,491	850,134	1,559,980

The spiced and pickled herring and "anchovies" preserves are semi-sterile, as the fish after being packed in cans ("anchovies" also in kegs) are <u>not</u> subjected to any sterilization process.

1. Manufacture of "gaffelbiter"

As for the manufacture of "gaffelbiter", also called "tidbits", Iceland summer herring constitute the raw material for this product. The herring are salted in barrels with a mixture of salt, sugar and spices, according to the regulations put down by the Norwegian canning industry, viz : for 100 kg beheaded Iceland herring :

13-15.0 kg salt
6.0 " sugar
1.4 " spices.

During the curing process the fish undergo a ripening due to the action of enzymes in the fish flesh, and from the bacteria developing in the pickle. When the fish are sufficiently cured and have obtained the

desired palatable quality, they are skinned, entrailed, boned, cut in suitable pieces and packed in cans with different spiced sauces made of tomato paste, sugar, vinegar, etc.. As the natural ripening process of the fish is progressing in the cans, spiced and pickled herring and "anchovies" products, thus being perishable commodities, must consequently be kept in cold storage to retard further fermentation and autolysis of the fish.

2. Manufacture of "anchovies"

As for the "anchovies" the raw material is usually Norwegian brisling. The fish are packed in the round condition in barrels with salt, sugar and spices, in accordance with the regulations of the canning industry, for 100 kg of brisling :

12.0 kg salt
7.0 " sugar
1.4 " spices.

For the packs with the finest quality of " anchovies " the fish are cured directly in special "anchovy" tin cans with pressure lids, and sold as "originally spiced anchovies".

Besides these packs " anchovies " are also cured as mentioned in barrels, subsequently transferred into the same tin packing material and sold as "delikatesse-ansjos".

"Anchovies" cured in barrels are also used as raw material for "appetitt-ansjos", which are cured fish, filleted and packed in cans with special spiced sauces.

The wide popularity of these spiced and pickled herring and "anchovies" preserves is due to their rich flavour and palatability. Their culinary use is restricted to hors-d'oeuvres or appetizers; they are not eaten as staple foods. From a commercial point of view these products have, as mentioned, a restricted shelf-life dependant upon the storage temperature. In order to prolong the keeping quality of these spiced and pickled fish products, preservatives such as sodium benzoate, esters or paraoxybenzoic acid and hexamethylenetetramine are used, the latter being permitted only in the following countries : Norway, Sweden, and Germany. For securing the consumers products of good quality, the Norwegian spiced and pickled herring and " anchovies " preserves are from 1950 submitted to a regular quality control by the control division of the Research Laboratory of the Norwegian Canning Industry, Stavanger, with the authorization of the Norwegian government. A special control is executed with commodities intended for export.

From this survey it is apparent that spiced and pickled herring and "anchovies" are unstable products, as the fermentation will proceed in the commercial packs. It is not possible to make them stable by applying for instance heat treatment to these products, as this would result in coagulation of the protein, and impair not only the texture of the fish, but also the flavour of these highly palatable products.

The bacteriological and chemical changes will finally result in a completely autolyzed product, where the fish in the most advanced stage will be of a "soup" consistency. The gas production accompanying these changes, will result in blowing of the cans. This is, however, not always the case, and advanced fermentation and autolysis may occur in cans of normal condition. The speed of the ripening process occuring in the cans is dependant upon the temperature of storage, and will be highly accelerated at temperatures about 30°C. Consequently emphasis should be lain on the importance of storage of these products under refrigerated condition, preferably at temperatures from 0-5°C.

Considering the sanitary aspect of semi-preserves of fish, the high salt concentration and the pH of the products will warrant absence of pathogens and putrefactive anaerobes. Numerous feeding tests on experimental animals, rats, mice and kittens, have been carried out in our laboratory with spiced and pickled herring and "anchovies" preserves in different stages of ripening, also in an overripe condition from blown cans, showing in no cases a harmful effect.

It is of interest in this connection to call attention to the great consumption in the Orient of an Indian fish sauce, Nouc-Mam, which consists of a completely autolyzed fish product prepared by curing a small fish belonging to the Clupeidae species in acid brine until complete autolysis.

In packs of herring preserves the break down of the protein will often result in separation of crystalline tyrosine, appearing on the surface of "gaffelbiter" and "anchovies" as white spots, giving the packs an abnormal appearance. This tyrosine separation resulting naturally through bacterial break down of the fish protein, in not a phenomenon peculiar to these fish preserves, but is also observed in products as for instance marinated fish, canned crab, russian caviar, etc...

A definite defect in spice-cured herring is the sliminess that occurs occasionally in the "spice-cured" herring in barrels, and also in packs of "anchovies". It is generally concluded that the slime is a carbohydrate gum produced by certain bacteria. Much research work has been done for elucidation of this question which is rather complex.

3. Miscellaneous fish preserves

A short mention will be made of the preparation of other fish preserves. The marinated products are preserved by chemical agents. The general procedure is to cure the fish fillets in an acetic acid-salt brine. The packing is done after a short cure, and the fish are packed in cans with spiced sauces containing preservatives. These products have a short keeping quality and must be kept in cold storage.

Of other fish preserves will be mentioned smoked herring fillets in oil. This product is preserved by a combined effect of salt curing, drying and smoking. The raw material is hard-salted herring which, when ripe, is smoked, filleted, cut in suitable pieces and packed with oil. A similar product is made from salmon. During the smoking process various chemical compounds are formed which have bactericidal or bacteriostatic effect. The keeping of the smoked fish fillets will depend upon the degree of drying, smoking and amount of salt in the fish. An addition of preservatives to the oil will enhance the keeping quality of the product.

Cod roe caviar is prepared from fresh cod roe which undergoes a curing process with sugar and salt in barrels. When the roe is sufficiently ripe and have obtained the right flavour, it is smoked, mixed with different ingredients and packed in cans. The addition of preservatives will also be necessary for this product.

II. PRINCIPLES OF PRESERVATION BY SALTING

The preparation of spiced and pickled herring and "anchovies" preserves is based on the principle of salt curing of the fish. When the herring are "spice-salted" in barrels in the traditional way with salt, sugar and spices, a series of processes will take place in the salted fish. These changes are, as already mentioned, due to the activities of enzymes naturally present in the fish flesh, and to those produced by the bacteria developing in the fish flesh and in the pickle. The problem of fish curing is very complex, and much research work is still necessary for solving many questions. The fish influenced by the different ingredients will undergo a ripening process, which in part is due to the penetration of salt and sugar into the fish flesh. As practically no water is added, only some brine to fill up the empty space caused by shrinking and settling of the fish, the pickle which is formed in the barrels consists mostly of the natural juice extracted from the fish flesh. In this juice sugar and salt will be gradually dissolved until a state of equilibrium between the sugar and salt concentration in the fish tissue, and in the pickle is reached. The conditions for these processes and speed at which they occur will be illustrated later in reporting the experiments with Norwegian winter herring carried out in our laboratory.

The raw fish will gradually change in character. This is in part due to the coagulation of the proteins, coagulable by sodium chloride. The simultaneous presence of sugar will, however, contribute to a certain elasticity and softness of the fish tissue. The physical and chemical changes in the fish will be accompanied by a bacterial fermentation. There will thus be an interaction between the physical, chemical and bacterial processes. The break down of the protein, mostly through the bacterial development and effect of enzymes, will contribute to the production of a special, ripen flavour, and the fish will gradually be transferred into a more digestible form. At the full - ripened stage the fish are readily skinned and the bones easily loosened. The consistency of the fish flesh has changed from being raw and tough, to be soft and palatable, the fish having a delicious flavour. At this mature stage the fish are ready for filleting and packing in cans. The fermentation process and enzymatic changes will proceed in the cans and result in a softening of the fish, and finally in a completely fermented and autolyzed fish flesh. This ripening is as already mentioned often accompanied by fermentation with production of gas (CO_2), resulting in blowing of the cans. In many cases, however, there will be no gas development, even in cans where the fish are completely desintegrated. The cans in the latter case bear no external signs of containing a product unfit for consumption.

III. ENZYMATIC ASPECT OF THE SALT CURING PROCESS

Let us now consider more in detail the agents bringing about the above mentioned ripening occurring in the salt curing process, in the first place the enzymatic changes.

There are different preautolytic processes going on immediately upon the death of the fish. One of these is the glycogenase which will transform the muscle glycogen to lactic acid, resulting in a stiffening of the tissue, and occasioning the rigor mortis. The pH of the muscle will show a lowering of from about 6.6 to 6.2, and as long as this pH is maintained, the muscle is protected against bacterial invasion. This state will, however, not last very long. The speed at which the rigor mortis sets in and its duration will vary with different factors, such as species of fish, way of catching, temperature etc... Once the rigor is resolved, and the pH is favourable for bacterial development, the invasion of bacteria will occur. The autolysis due to the naturally occurring enzymes in the fish present in blood, glands ans muscles, is negligible compared with that owing to bacterial activity. From a chemical point of view autolysis is a proteolytic process.

As most enzymes are destroyed or rendered inactive by concentrated salt solutions, it is evident that during the salting process the gradual penetration of salt into the fish flesh will retard the proteolysis due to the natural enzymes in the fish flesh, and this retardation will be considerable at a salt concentration of 10 %. During the curing process the salt in higher concentrations will also have a marked preservative effect.` While about 3 % of sodium chloride is favourable to most bacteria, a concentration of 10 - 15 % will prohibit the growth of proteolytic types. In the fish flesh and in the pickle, therefore, there will be a special microflora which is favoured by high salt concentrations and which, most probably, contribute to the characteristic flavour of the fish, produced during the ripening process.

IV. BACTERIOLOGICAL ASPECT OF THE SALT CURING PROCESS

Which are the bacteria to be expected during the curing of herring ? Investigators of fish bacteriology are in general agreement concerning the sterility of the fish flesh of healthy live fish. The skin, gills and intestines of the fish will, however, harbour big loads of bacteria, and these organisms are of marine origin. It is generally concluded that the invasion of bacteria occurs via the gills, from the slime through the skin, as well as from the intestines into the fish flesh.

Experiments were carried out in our laboratory with samples of winter herring and other species of fish to examine the sterility of freshly caught fish. The fish were brought in a live condition into the laboratory, and subsurface samples of fish were aseptically removed for examinations. The experiments included 140 muscle samples, and the results confirmed the conclusion of previous investigators.

The distribution and amount of bacteria present in freshly caught winter herring have also been the object of our investigation. This particular fish is of importance, not only for the salt fish industry, but also for the canning industry as raw material for canned kippered herring. In view of the significance of the initial flora of the herring influencing the sanitary standard of the fish used for the mentioned purposes, a study of the organisms present in fresh fish was undertaken. The investigation was carried out during two winter seasons, and included examinations of fresh fish right out of water. Samples from the skin, gills and intestines of this fish were studied, and a quantitative as well as qualitative analysis of the bacteria present from the mentioned sources were established. The following table shows the composition of the bacterial flora of the fish expressed as percentage of total numbers of organisms isolated :

Source of sample	Achromobacter	Micrococcus	Flavobacterium	Pseudomonas	Miscellaneous (Bacillus etc.)
Slime	24.5	16.7	17.7	40.0	1.1
Gills	13.7	3.9	33.4	47.0	2.0
Intestines	72.5	3.4	-	24.1	-

As one would expect these bacteria are typical water bacteria, and there seems to be no evidence of a particular group of bacteria typical for herring. The bacterial flora was aerobic; strict anaerobes were not demonstrated in any samples.

The majority of these fish bacteria are psychrophilic, growing at temperatures between 0° and 30°C, some being able to develop at ice temperature. Among these bacteria were demonstrated species with active proteolytic enzymes. The Achromobacter included trimethylamine oxide reducing bacteria which together with the proteolytic types will cause proteolysis of the fish.

Regarding the bacteria present during the salt curing process, consideration must also be given to bacteria contaminating the ingredients used in " spice-salting ", namely, besides the salt, also sugar and spices. As for the salt the bacterial flora will depend upon the kind of salt used. Solar salt often used in curing processes, for instance of cod fish, contain a great number of halophilic or "salt-loving" bacteria which are mostly cocci. These bacteria will develop in concentrated salt solutions, and take part in the fermentation process. Other kinds of salt, as rock salt and vacuum salt, especially used for spice-curing of herring, are practically free from bacteria. As for the bacteria present in sugar, it is well known that sugar may harbour spore-forming organisms among which are thermophilic bacteria, but presence of the latter will not be of importance during the curing process owing to the low temperature used under this process. Other microorganisms as yeasts and molds will also be contaminants in sugar, but they will probably be of minor importance. The spices used as ingredients for flavouring of the fish contain mostly aerobic spore-forming bacteria.

Of the numerous salting experiments carried out in our laboratory for the purpose of studying the micro-flora occurring during the curing period at different stages of fermentation, a report will be given on two experiments with "spice - salting" of Norwegian winter herring. In these experiments bacteriological examinations of the fish, as well as of the brine, was accompanied by chemical analyses of the same material. When the fish were sufficiently cured, the herring were packed as "gaffelbiter" in cans, and corresponding bacteriological and chemical examinations were made from the " gaffelbiter " at regular intervals. It was hoped in this way to obtain a clearer picture of the processes going on during the course of curing of the fish in barrels, and of the same fish packed as "gaffelbiter" in cans. The following experiments were carried out :

Series 1 (regular "spice-salting") : The winter herring was of normal quality and "spice-salted" in barrels. The curing agent was composed of a mixture of 12 kg of vacuum salt, 6 kg of sugar and 1.5 kg of spices per 100 kg of beheaded herring. The salting was done in barrels in accordance with the regular procedure.

Series 2 ("spice-salting" of acid-treated fish) : The winter herring was previous to salting treated in a bath with acetic acid (3 %) for 1 hour. At the end of this period the fish were removed from the bath, drained and subsequently "spice-salted" according to the regular curing formula as in series 1.

Both barrels were kept at temperatures of about 10 - 15°C. and subjected to regular inspection. Samples were removed at intervals for organoleptic tests and for bacteriological and chemical analyses. The acid-treated herring, series 2, arrived in a cured stage prior to series 1, and were used for packing of "gaffelbiter" after 73 days of curing.

Two series of packs were made :

a) with ordinary sauce of sugar, vinegar and extract of spices;

b) with the same sauce to which were added preservatives (benzoic acid and hexamethylenetetramine, 0.25 grams and 0.05 grams respectively per 100 grams of total contents of cans).

The fish were packed in two 2 kg cans for each series and hermetically sealed. Samples of brine and fish were at certain intervals removed aseptically from the cans for bacteriological and chemical analyses, after which the contents of the cans were repacked aseptically in smaller containers, the proportion between fish and brine being kept constant at each transfer.

For determination of the micro-flora in the fish, the whole fish with intestines etc. were ground, precautions being taken to avoid contamination during the grinding.

The bacteriological examination included in the first place a determination of viable bacterial counts. The culture media were salt agar (2.5 % salt), and sugar-salt agar (5 % sugar + 5 % salt). As

marine bacteria are very sensitive to heat, great attention was paid to the plating temperature which was kept the lowest possible. Petri-dishes were used for aerobic counts, deep agar tubes for anaerobic.

For the counting of yeasts wort agar plates were used. The agar plates and deep agar tubes were incubated at 22°C, and observed for growth during a period of 3 weeks, time necessary for the slow-growing halophilic types of bacteria. Yeast colonies were counted after a few days.

In addition to the quantitative study of the micro-flora present at different intervals during fermentation, the investigation also included a qualitative examination of the flora. Representative colonies from the plates and tubes were subjected to isolation and further study for identification. It was intended to establish the approximate composition of the micro-flora, and thus follow the sequence of changes occurring in this.

V. RESULTS OF CHEMICAL AND BACTERIOLOGICAL EXAMINATION

a) Spice-salted herring in barrels

b) "Gaffelbiter" in cans packed from this spice-salted herring

The results of the determination of viable bacteria and yeasts are summarized in the following tables I, II, III and IV. With reference to tables I and II it is apparent that the viable bacterial counts are increasing during the curing process in the herring as well as in the brine, the latter showing the highest figures. The aerobic counts are as a rule in excess of the anaerobic. The ripening process reaches its maximum after about 3 months for series 1, already after about 2 months for series 2, the acid-treated herring. It is noticeable that the counts are lower in series 2, owing to the bactericidal effect of the acetic acid on the initial flora of the herring. This series also reaches a full-ripe stage with bacterial counts much lower than in series 1. As for the yeasts, these organisms were present during the ripening process, but declined, and were not demonstrable in advanced fermentation.

TABLE I

Microflora of "spice-cured" winter herring - Series 1

Days of curing at temp. 12 - 15°C	Organoleptic examination of herring	Average bacterial count in 1000 per gram at 22°C.				Average yeast count in 1000 per gram.	
		Herring		Brine		Herring	Brine
		aerobes	anaerobes	aerobes	anaerobes		
0		7,000	250	-		-	-
21	Taste raw	800	500	600	100	-	-
69	" "	600	70	4,700	200	20	30
98	Ripe Taste good Consistency normal	34,000	15,000	550,000	330,000	22	13
154	Over-ripe "Sour" Fish flesh red	74,000	50,000	640,000	500,000	0	0

TABLE II

Microflora of "spice-cured" winter herring - Series 2
(acid treated raw material)

Days of curing at temp. 12 - 15°C	Organoleptic examination of herring	Average bacterial count in 1000 per gram at 22°C.				Average yeast count in 1000 per gram.	
		Herring		Brine		Herring	Brine
		aerobes	anaerobes	aerobes	anaerobes		
21	Almost ripe	100	10	340	50	0.050	-
69	Ripe Taste good Consistency normal	50	9	30	500	900	600
154	Over-ripe "Sour"	3,000	500	5,000	10,000	0	0

Considering the initial bacterial flora, this was composed of typical water bacteria belonging to the genera Pseudonomas, Achromobacter, Flavobacterium and Micrococcus, which are psychrophilic and include proteolytic types. As fermentation proceeded, a marked change in the flora occurred, as the rods disappeared, and the plates and tubes were crowded with very small bacteria which proved to be micrococci. These halophilic organisms, which are facultative anaerobic, were the predominating types when the fish arrived in the ripe stage, and seemed to play an active part in the curing process.

Regarding the micro-flora of the packed "gaffelbiter" in cans during storage, table III gives the bacteria and yeast counts. There is a constant increase in the bacterial counts both in the "gaffelbiter" and in the spiced sauce. In the highly blown can the figures are about 3 billions for both aerobes and anaerobes. The yeasts originally present in the cans do not seem to take part in the further fermentation process.

Concerning the composition of the micro-flora it is noticeable, that the halophilic cocci were the predominating types during the fermentation of the packed "gaffelbiter". As for the biochemical activities of these bacteria and the part they play in the enzymatic processes during the ripening of the "gaffelbiter", and when the fish arrive in advanced and overripe stage of fermentation, there is much research work yet to be done.

Referring to table IV the bacterial counts are very low, thus the influence of the used preservatives is strongly marked. The bacterial development is kept in check, the counts remaining constant after about 4 months" storage of the cans.

TABLE III

Microflora of "gaffelbiter" packed (in cans) of cured winter herring from Series 2 with spiced sauce

Pack A without preservatives

Days of storage Temp. 22°C	Condition of can	Organoleptic examination of "gaffelbiter"	Average bacterial count in 1000 per gram at 22°C				Average yeast count in 1000 per gram	
			"Gaffelbiter"		Spiced sauce		"Gaffelbiter"	Spiced sauce
			aerobes	anaerobes	aerobes	anaerobes		
7	Normal	Normal	1,000	0.1	260	0.5	0.4	17
35	Blown	Taste sour Consistency soft	10,000	15,000	52,000	17,000	0.5	0
59	Highly blown	Taste sour Consistency soft	2,400,000	2,500,000	2,900,000	2,800,000	0	0

TABLE IV

Microflora of "gaffelbiter" packed (in cans) of cured winter herring from Series 2 with spiced sauce

Pack B with preservatives

Days of storage Temp. 22°C	Condition of can	Organoleptic examination of "gaffelbiter"	Average bacterial count in 1000 per gram at 22°C				Average yeast count in 1000 per gram	
			"Gaffelbiter"		Spiced sauce		"Gaffelbiter"	Spiced sauce
			aerobes	anaerobes	aerobes	anaerobes		
7	Normal	Taste normal Consistency normal	900	0.6	14	0.4	0.4	0.6
35	"	"	3	11	14	0.6	0	0
59	"	"	7	100	8	8	0	0
142	"	"	9	2	6	3	0	0

The bacteriological changes during spice-curing of herring and during storage of the packed "gaffelbiter" from this fish must, however, be considered in close relation to the chemical changes occurring in the fish, as well as in the brine. Tables V and VI (p. 7) give a summary of the results of the chemical analyses, and show the changes occurring in the two series of "spice-salted" herring in barrels.

The break down of the protein have been demonstrated in the figures for total volatile bases, which show a steady increase during the fermentation process. It is of interest to note that the total volatile bases show higher values in the normal " spice-salted " herring, series 1, than in the herring acid-treated

rior to the "spice-salting", series 2. The most advanced protein break down in series 1 was accompanied y the highest bacterial counts. But on the other hand the stage of ripening of the fish was reached earlier y the acid-treated fish, series 2, which may be explained by the lower pH in this series (about 5.7), as ompared with pH in series 1 (about 6.4), which seems to favour the activity of proteolytic enzymes. The nitial bacterial flora of fish include proteolytic types, among which are active trimethylamine oxide reucers. The decrease of the trimethylamine oxide naturally present in the herring may be due to the activity f these bacteria. The rate of trimethylamine oxide reduction is highest in series 1, and the reduction is omplete when the fish reach the ripe stage. In the acid-treated fish, series 2, the reduction occurs more lowly.

TABLE V

Chemical analyses of "spice-cured" winter herring. Series 1

Days of curing at temp. 12-15°C	pH		Total volatile bases mgN/100 g		Ammonia mono-methylamine mgN/100 g		Trimethyl-amine mgN/100 g		Trimethyl-amine oxide mg /100 g		Total amino acids mg /100 g		Total sugar g/100 g		Invert sugar g/100 g		Salt g/100 g	
	herring	brine	herring	brine	herring	brine	herring	brine	herring	brine	herring	brine	herring	brine	herring	brine	herring	brine
0	6.54		16.8		8.4		8.4		53.2		81		0.		0		0	
5	6.42	5.84	54.5	18.1	19.5	7.0	35.0	11.2	30.8	26.6	120	65	0.6	11.2	0.1	0.7	6.1	17.3
21	6.38	6.30	75.6	69.7	36.4	43.4	39.2	46.3	12.6	22.4	143	117	3.6	6.8	0.6	1.5	8.4	11.9
69	6.35	6.74	111	138	64	75	47	63	2.1	0	178	219	4.5	6.0	2.0	3.0	9.4	12.0
98	6.5	5.7	130	171	80	107	50	64	2.8	0	253	285	4.6	5.0	2.4	3.3	9.4	12.0
154	4.96	4.70	167	179	108	117	59	62	0	0	332	367	3.4	4.1	3.1	4.1	10.4	12.4

TABLE VI

Chemical analyses of "spice-cured" winter herring. Series 2

Days of curing at temp. 12-15°C	pH		Total volatile bases mgN/100 g		Ammonia mono-methylamine mgN/100 g		Trimethyl-amine mgN/100 g		Trimethyl-amine oxide mg /100 g		Total amino acids mg /100 g		Total sugar g/100 g		Invert sugar g/100 g		Salt g/100 g	
	herring	brine	herring	brine	herring	brine	herring	brine	herring	brine	herring	brine	herring	brine	herring	brine	herring	brine
0	5.68		14		9.1		4.9		58.1		80.4		0		0.		0	
5	5.84	5.00	36.4	16.8	15.4	7.0	21.0	9.8	40.5	28.0	120	66	1.3	11.2	0.8	1.2	6.1	20.7
21	5.86	5.65	51.8	64.5	25.2	30.9	26.6	33.6	22.4	32.2	162	132	3.6	7.1	0.5	1.9	8.3	11.5
69	5.60	5.64	69	92	47	56	22	36	21	6.3	238	265	4.9	6.4	2.1	3.5	9.5	12.0
154	5.52	5.52	97	110	63	76	32	34	13	24	345	394	3.7	6.2	3.6	6.1	10.6	12.4

As for the amino acids the increase goes parallel in the two series. No definite conclusions can be drawn with regard to relation between the amino acid production and the bacterial development during the ripening process.

The sugar will penetrate from the brine into the fish, and reach its maximum when the fish are in the ripe stage.

As for the salt this will penetrate from the brine into the fish and show a steady increase towards an equilibrium in both series. The concentration of salt in the fish at the full-ripe stage in both series is about 9.5 %.

In the packed "gaffelbiter", tables VII and VIII (p.9), the total volatile bases are steadily increasing. The trimethylamine oxide reduction seems to occur more rapidly in pack A without preservatives, than in pack B. As for the total amino acids there is a regular increase in both series. The pH values in pack A show a decrease from 5.03 to 4.9, and this change occurs when the fish reach an overripe stage, and the organoleptic test shows "souring". In pack B where the fish remained organoleptically normal, the pH value seems to have a tendency to a slight increase.

From the results recorded above it appears that more basic knowledge is needed concerning the processes involved in the "spice-salting" of herring and "anchovies", and in the packs from these raw materials. This research should comprise bacteriological and biochemical changes occurring during the fermentation, and may contribute to solving some of the problems concerning the keeping quality of these fish preserves. There is thus an interesting field of research open for investigators of fish microbiology.

TABLE VII

Chemical analyses of "gaffelbiter" packed (in cans) of cured winter herring from Series 2 with spiced sauce

Pack A without preservatives

Days of storage. temp. 22°C	pH		Total volatile bases mgN/100 g		Ammonia mono-methylamine mgN/100 g		Trimethyl-amine mgN/100 g		Trimethyl-amine oxide mg /100 g		Total amino acids mg /100 g		Total sugar g/100 g		Invert sugar g/100 g		Salt g/100 g	
	her-ring	brine	her-ring	brine	her-ring	brine	her-ring	brine	her-ring	brine	her-ring	brine	her-ring	brine	her-ring	brine	her-ring	brine
7	5.03	5.03	67	77	43	52	24	25	8.	14	217	256	12.6	15.7	2.2	2.4	7.1	8.5
35	4.89	4.90	78	91	51	62	27	29	2.9	1.4	308	344	12.3	12.6	1.0	1.4	7.6	10.1
142	4.90	4.93	98	110	69	78	29	32	0	0	485	580	11.8	13.8	3.2	3.9	7.3	8.3

TABLE VIII

Chemical analyses of "gaffelbiter" packed (in cans) of cured winter herring from Series 2 with spiced sauce

Pack B with preservatives

Days of storage temp. 22°C	pH		Total volatile bases mgN/100 g		Ammonia mono-methylamine mgN/100 g		Trimethyl-amine mgN/100 g		Trimethyl-amine oxide mg /100 g		Total amino acids mg /100 g		Total sugar g/100 g		Invert sugar g/100 g		Salt g/100 g	
	her-ring	brine	her-ring	brine	her-ring	brine	her-ring	brine	her-ring	brine	her-ring	brine	her-ring	brine	her-ring	brine	her-ring	brine
7	5.03	5.03	69	84	49	57	20	27	15	14	207	245	12.3	17.0	1.9	2.4	7.2	8.5
35	5.04	5.05	70	90	53	68	17	22	9.8	12.6	279	327	11.4	16.0	2.0	2.7	6.4	8.3
142	5.15	5.17	103	122	72	88	31	34	0	0	450	576	11.7	14.7	3.5	4.3	7.4	8.5

XXXIV. STUDIES ON THE PROCESSING OF "FOIE GRAS"

by P. FLEURET, J. DUROCHER, Miss M.-L. THUILLOT, Miss C. TARDIVON and H. CHEFTEL (France)

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I. INTRODUCTION

Two kinds of problems are met with in the canning of "foie gras" (1): firstly, those related to the production of livers of the proper quality, which is a question of farming, breeding of the geese, selection of the feed, method of cramming, and choice of the livers; secondly, those related to the canning operations and particularly to the processing.

The problem of properly processing "foie gras" can be put into the following terms : is it possible properly to preserve the product solely by heat processing without serious impairment of its organoleptic properties - or should one be content with preparing a semi-sterile product ?

In order to find an answer to this question, we have undertaken three series of experiments :

1). The establishment of heat penetration curves in variously sized cans of "foie gras" ("entier au naturel", "pâté" and puree) (2);

2). Commercial scale canning tests with various processing times and temperatures;

3). Laboratory tests on the processing of cans of "foie gras" inoculated with spores suspensions of heat resistant microorganisms.

II. HEAT PENETRATION

Figures 1 and 2 (p. 2) give some of the curves which have been obtained by automatically recording the temperature with a recording potentiometer. This series of experiments has shown that the three types of foie gras products (whole, "pâté" and puree) behave similarly with respect to heat penetration : they all heat solely by conduction, as does any potted meat.

III. COMMERCIAL SCALE CANNING TESTS

Practical experience of the canning of foie gras indicates that it is impossible to heat process either whole "foie gras" or "pâté de foie gras" above 110°C (230°F) without seriously impairing its texture and its organoleptic properties on which its value depends. This has been confirmed by laboratory tests and by histological studies.

On the other hand, the heat penetration measurements lead one to think that the processing times and temperatures ordinarily used in commercial practice have little chance of effecting complete sterilisation.

It has nevertheless been thought advisable to investigate more closely, by two series of experiments made in two different factories, what efficiency the usual processes do really possess. Table I (p.3) gives the results of these tests. These results show that the processes used in these experiments are not sufficient

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(1) Fat liver obtained by cramming of geese.

(2) "foie gras entier au naturel" consists of whole livers or one single piece of liver, with nothing added but salt; "pâté de foie gras" - contrary to "pâté de foie" which is in minced or pureed form - consists of relatively large pieces of "foie gras" surrounded by a special stuffing.

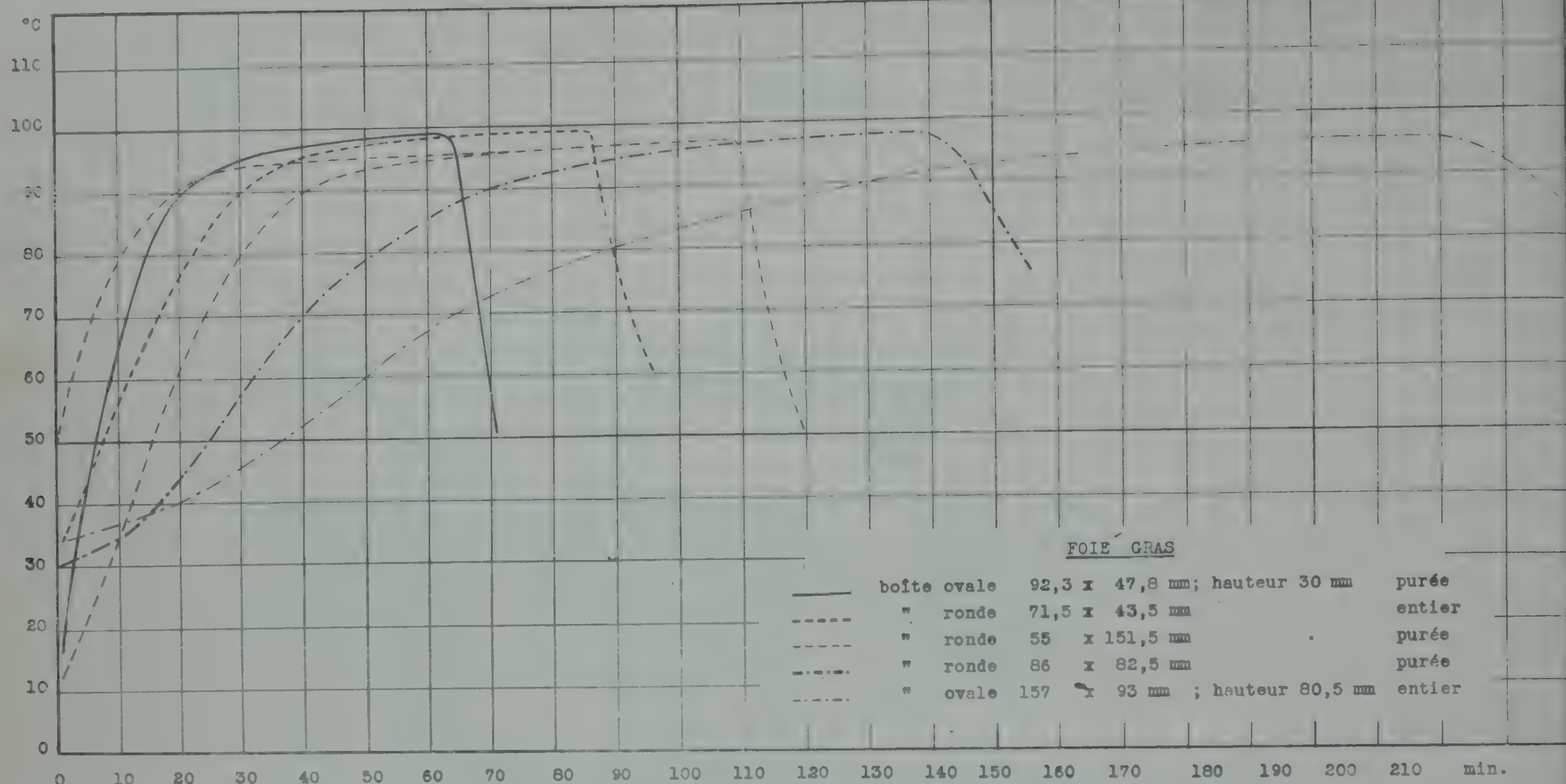

Fig. 1. Temperature at center of can as a function of time. Processing at 100°C (212°F).

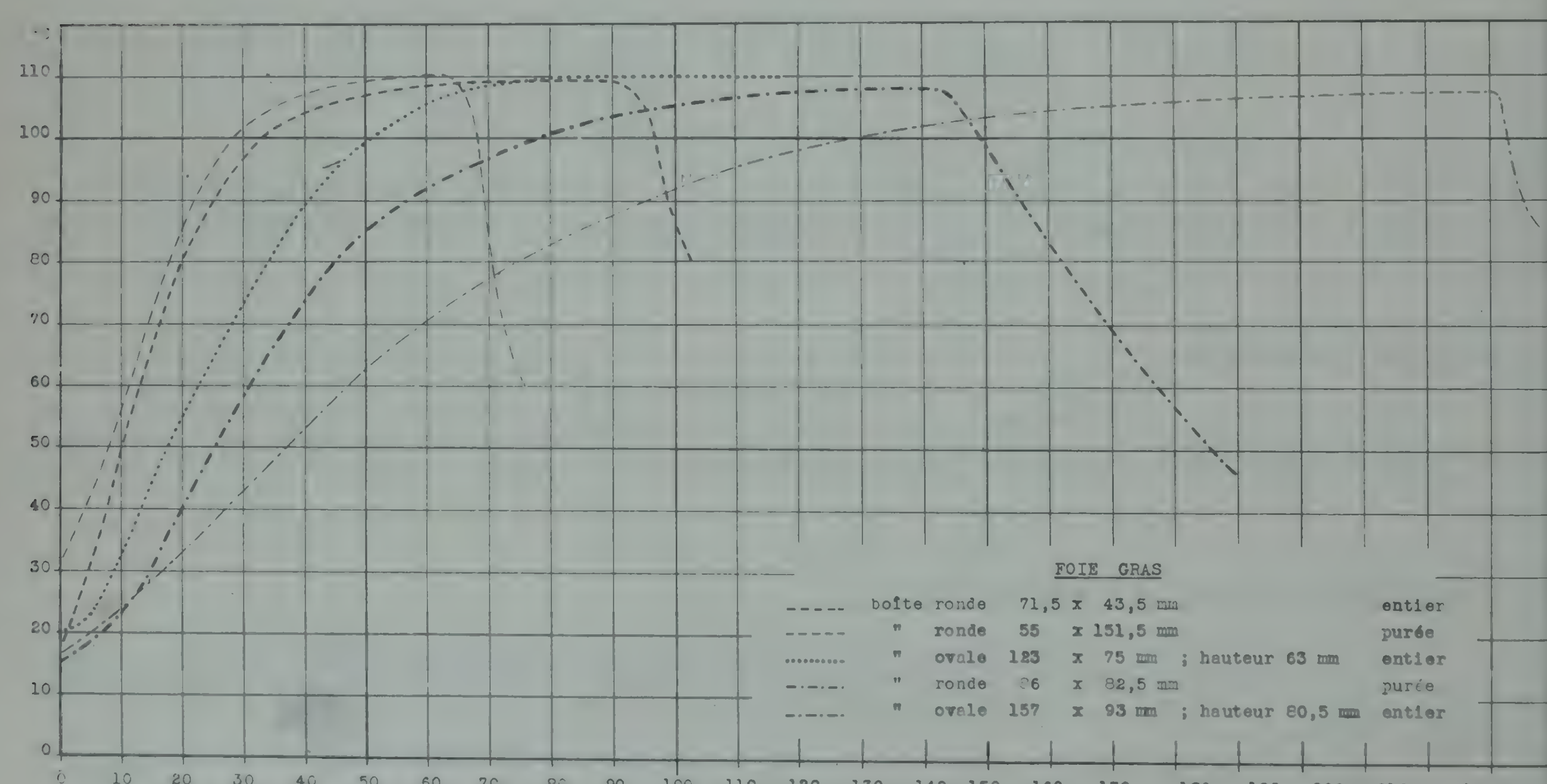

Fig. 2. Temperature at center of can as a function of time. Processing at 110°C (230°F).

to ensure that it will keep at high storage temperatures. Notwithstanding some irregular results, due to the fact that the experiments have been made with a rather limited number of cans, it is apparent that a processing temperature of at least 108°C (226°F) is necessary to reach a certain degree of safety as to the keeping quality of the product, unless cool storage is resorted to.

TABLE I

Processing of canned whole "foie gras au naturel"
Oval cans 106 x 66 x h.44 mm. (approx. 400 x 219 x height 103) - 200 g (approx. 7 oz.) of product per can
Filling temperature : 10°C (50°F) - Water cooled after processing.

Processing			Factory No.1 (Paris)							Factory No.2 (Aire-s/-Adour)						
Temperature		Time	Number of test cans	Swells						Number of test cans	Swells					
				at 37°C (98.6°F)		at 55°C (131°F)		Total			at 37°C (98.6°F)		at 55°C (131°F)		Total	
(° C)	(° F)	(minutes)		number	p.100	number	p.100	number	p.100		number	p.100	number	p.100	number	p.100
100	212	60	30	11	37	2	7	13	43	30	9(+)	30	5	17	14	47
		75	22	5	22	3	13	8	35	30	2	7	4	13	6	20
		90	30	2	7	0	0	2	7	30	1	3.5	6	20	7	23.5
104	219	35	30	4	14	0	0	4	14	30	17	57	4	13	21	70
		50	30	0	0	0	0	0	0	30	0	0	4	13	4	13
		70	30	1	3.5	0	0	1	3.5	30	0	0	3	10	3	10
108	226	30	30	1	3.5	0	0	1	3.5	30	0	0	4	13	4	13
		50	30	0	0	0	0	0	0	30	0	0	1	3.5	1	3.5

(+) One leaky can.

IV. PROCESSING OF INOCULATED CANS

It is obvious that when heat resistant bacterial spores are not present in the product, good preservation can be obtained by processing at 100°C (212°F). However, heat resistant species causing spoilage of the product and swelling of the cans are frequently isolated from swelled cans of foie gras. In 1950 we have found, in three distinct cases of spoilage, strains akin to Cl. sporogenes in their cultural characteristics and whose spores withstood heating at 100°C for more than 5 hours.

Such facts indicate that the possible presence of organisms of this kind has to be taken into account. Also, from the hygienic point of view, the possibility that spores of Cl. botulinum may be present should be kept in mind.

We have accordingly used one of the three strains - LH 3165 - mentioned above, and a strain of Cl. botulinum obtained from the Research Laboratories of the Metal Box Company, London (1), in order to investigate how far it is possible to reach complete sterility when either species is present, without impairment of the essential qualities of the product. It should be remembered that for a product as expensive as "foie gras", high quality is absolutely essential.

We do not think it is necessary to give in detail the preparation of media and of spore suspensions. Spore counts have been made by inoculating liver broth tubes in series of 2 x 10 with spore suspensions in successive decimal dilutions from 10^{-2} to 10^{-10}. Inoculations into cans were of 0.1 ml of 10^{-2} suspension, and corresponded thus to approximately 100,000 spores per can.

The cans used were of 71.5 mm diameter and 10 mm overall height. They were sterilized in an autoclave prior to aseptic filling with sterile foie gras, inoculating and closing with a sterile cover by double-seaming.

For the processing experiments, the cans were placed either in boiling water or in a steam retort. The small height of the cans allows of neglecting, for the times and temperatures used, the time taken for raising the centre temperature to the processing temperature. Minor variations of the initial temperature, which was about 20°C (68°F), may also be neglected under such conditions. After processing, the cans were cooled in water at about 12°C (54°F). They were then incubated at 37°C (98.6°F) and examined every 24 hours.

Tables II and III (p. 4) give the results recorded.

These results show, with regard to strain LH 3165 - isolated in a case of spoilage in a commercial pack - that long processes at relatively high temperatures are necessary to ensure proper keeping qualities (probably above 50 or 60 minutes at 108°C (226°F) at the centre of the cans. This point is being further investigated).

As regards Cl. botulinum, although we have chosen the most heat resistant strain at our disposal, no culturing expedient has enabled us to produce spores nearly as resistant as those encountered by some American authors, K.F. MEYER in particular. Nevertheless, one should not forget that such high resistances may occur. Even if the necessary processes in a medium like " foie gras " may not be as severe as the ones asked for by strain LH 3165, a certain margin of safety is essential.

It should be added that " foie gras " is much too expensive a product to admit the risk of manufacturing losses, even if the spoilage is quite obvious and without danger to the public.

(1) We wish to take this opportunity for thanking again the Research Laboratories of the Metal Box Company.

TABLE II

Processing tests of cans inoculated with strain LH 3165

	Negative control	Positive control	Series A	Series B	Series C	Series D
Number of cans	6	11	10	10	10	10
Number of spores inoculated	0	100,000	100,000	100,000	100,000	100,000
Process (temperature .	-	-	100°C=212°F	108°C=226°F	108°C=226°F	108°C=226°F
Process (time	-	-	180 min	25 min	40 min	80 min
Number of swells at 37°C (98.6°F)	0	11	6	10	5	0
Number of days to swell	no swells in 75 days	5 to 12	7 to 15	5 to 11	11 to 19	no swells in 75 days

TABLE III

Processing tests of cans inoculated with Cl. botulinum

	Negative control	Positive control	Series A	Series B	Series C
Number of cans	3	6	10	10	10
Number of spores inoculated	0	100,000	100,000	100,000	100,000
Process (temperature .	-	-	100°C=212°F	100°C=212°F	100°C=212°F
Process (time	-	-	30 min	45 min	60 min
Number of swells at 37°C (98.6°F)	0	6	10	7	0
Number of days to swell	no swells in 18 days	4 to 11	5 to 14	4 to 15	no swells in 18 days

Are such processes compatible with organoleptic qualities ? In our opinion they are not, at least as long as research on the breeding and feeding of geese has not taught us how to produce fat livers better capable of withstanding heating at relatively high temperatures, especially with regard to melting of the fat.

Thus the main conclusion which we would draw from the various experiments related above is that canned whole "foie gras" and "pâté de foie gras" are to be considered as SEMI-STERILE PRESERVES submitted only to a pasteurizing process, and which should be plainly labeled " KEEP UNDER REFRIGERATION ". (Pureed "foie gras", on the contrary, may be fully sterilized as most other potted meats).

On the other hand, it is essential that the livers be handled and treated so as to avoid as far as possible all contamination, to which end the following recommendations should be adhered to :

a) bleed the bird as completely as possible;

b) descard the practice of soaking the livers in brine, this being a frequent source of bacterial contamination;

c) trim and dress the livers, paying the greatest attention to cleanliness;

d) do not omit poaching the livers, preferably oven poaching, which has the advantage of eliminating serum.

Lastly, it seems essential that handlers, grocers and the consuming public be informed of the fact that canned "foie gras" and "pâté de foie gras" are SEMI- STERILE PRESERVES and will not keep unless stored under refrigeration.

XXXV. STUDIES ON THE PRODUCTION OF ANCHOVIES AT THE PORTUGUESE INSTITUTE FOR FISH PRESERVATION

Summary based on a report by Professor Ch. LEPIERRE (†)
and a note by J. MERCIER-MARQUES, Chemist (Portugal)

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Ch. LEPIERRE'S WORK

I. DESCRIPTION OF THE INDUSTRIAL PROCESS

The production of anchovy is a special treatment of a fish of the clupeoid family Engraulis encrasicholus whose common name is anchovy and which gives its name to the resulting product.

This product is prepared by placing the fish after beheading and degutting, in alternate layers with salt, either in wooden barrels or in tinplate cans. A layer of salt is first placed in the bottom of the container and a final layer of salt is also placed on top, on this is placed a weighted wooden disc. The fish in each layer are arranged parallel one to the other, and at right angles to those in adjacent layers. The weights pressing on the mass of fish are gradually increased but there are no precise rules for this, and there is no knowledge of how much compression is necessary.

Under these conditions water and fat are pressed out of the fish and they sink considerably in the first few hours, a liquid layer forming which is covered with fat. This liquid overflows and is collected and subsequently used to spray over the anchovies during treatment. This spray has the effect of maintaining the level of the liquid layer so as to facilitate the elimination of oil and other substances (blood, salt, and organic matter) brought out by the compression. Great importance is attached to the collection of this liquid to which is attributed a great influence on the quality of the final product. If this liquid is not available a brine of 25°Bé is used. The treatment continues thus at room temperature and at the end of six or seven months or more, according to the season, the fish have acquired different chemical and organoleptic qualities from those they had at the beginning, and maturation is complete.

The fish is flattened and takes on a red tint, the smell is pleasant and the taste very characteristic. The water, fat and protein content have decreased whereas the minerals, in particular sodium chloride, have increased.

It is at this time that the fillets are prepared by cutting, removing the bone, washing and skinning and then packing in cans with oil. In practice these operations are carried out in fairly primitive conditions from the hygienic point of view, sometimes with no care for cleanliness at all. No doubt it is felt that the high proportion of salt makes this unnecessary, but this is a mistake for such conditions are not antiseptic, but merely unfavourable to the growth of certain micro-organisms and favourable to others.

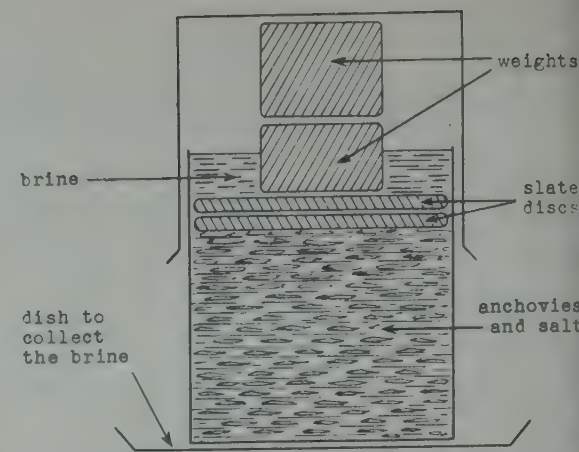
II. PLAN OF THE EXPERIMENTS

The first factor which we proposed to investigate was a comparison between the production of anchovies as is done commercially and under conditions as sterile as possible. We also compared the result of doing this at three different temperatures, room temperature (15 - 30°C) 37°C and 50°C. At the same time we

(+) The author of this summary is H. CHEFTEL, Directeur, Laboratoire de Recherches, Etablissements J.J. Carnaud et Forges de Basse-Indre (France).

(++) The late Mr. Ch. LEPIERRE was Professor at the Technical Institute of Lisbon and Director of the Laboratory of the Portuguese Institute for the Preservation of Fish.

studied the effet of varying certain analytical components, water, fat, ash, total nitrogen, ammoniacal nitrogen, amino nitrogen and pH.



Equipment and method

We used as a container for the fish circular tin cans which were covered by a second can of a slightly larger diameter.

We used cans of 110 mm diameter, and 77 mm high (720 cubic cm capacity) covered by cans of 125 mm diameter of the same height. We also used cans of 150 mm diameter and 110 mm high (capacity 1900 cubic cm) covered by 155 mm diameter dans of the same height.

The weights used to compress the material were discs of slate 3 cm thick and of a suitable diameter, on these were placed cubes of granit. We thus were able to obtain pressures of 132 grams per square cm in the smaller cans and 60 grams per square cm in the larger cans. Each cans was stood in an enamelled tray so that the liquid which overflowed could be collected.

III. EXPERIMENTS CARRIED OUT

1. First series 1941

Summer fish-fat content 16/20%

For the experiments in producing anchovies aseptically, the containers, salt, discs and weights were previously sterilised in a retort at 120°C, the salt was baked in an oven at 150°C the brine at 25°Bé was boiled for twenty minutes, and finally the fish after beheading and evisceration were rinsed carefully with boiled distilled water and placed in the containers so as to avoid all contamination.

Temperature	15 - 30°C	37°C	50°C
Conditions of the process :			
Without asepsis	I	III	VI
Without asepsis at the testing station	VIII	VIII	VIII (p.16)
Aseptic	II	IV	VII
on fish previously heated to 100°C	(p.11)	(p.13)	(p.15)

The indications above refer to the tables of the original paper and to those on page 4.

Cotton wool between the container and lid prevented the entry of dust. The cans of 110 mm diameter held 45/48 fish, those of 150 mm diameter 90 fish. The experiments carried out at the experimental station were done in industrial containers.

These experiments have shown :

1. that carrying out the process at 37°C or 50°C resulted in products quite unacceptable from the organoleptic point of view, (soft fish and abnormal smell);

2. that at room temperature (15/30°C) the results under aseptic conditions were identical to those without asepsis both from the chemical and organoleptic point of view.

A new series of experiments was carried out in the following conditions.

2. Second series 1942

Autumn fish -fat content 7.5 %.

Temperature : 15 - 30°C (room)	
Preparation :	
Aseptic (control)	Table A
" with addition of Group I bacteria	Table B
" with addition of Group II bacteria	Table C
" with addition of Group III bacteria ...	Table D

The bacteria thus introduced into the medium came from cultures made from products of the first series of experiments divided into three groups.

Group 1. Gramm positive bacilli sporing or non sporeforming,
Group II. Gramm negative bacilli,
Group III. Gramm positive bacilli and diplococci.

The introduction of these bacteria was done by spraying with a suspension of the bacteria in brine instead of brine at 25°. The results obtained confirm the indications of the first series of experiments namely that the bacterial flora does not appear to play a part in the process of anchovy production.

3. Other experiments

1. Experiments were carried out to determine the weight relationship of the process. The average results show that beheading and evisceration result in a loss of the order of 30 %. The anchovy

rocess itself results in a further loss of 40 % on the beheaded and eviscerated fish.

Thus 100 kilograms of whole fresh anchovies give approximately 70 kilograms fresh beheaded an-ovies, and 40 kilograms of processed anchovies.

2. Histological examinations of the muscles in the dorsal region of the anchovy during processing ere carried out by Professor Celestino DA COSTA of the Faculty of Medicine of Lisbon. This enabled the slow tolysis of the tissues to be observed during which the nucleus disappeared first while the cytoplasm re-ained, even after fifteen months, its cohesion and staining properties with eosin.

Mr. DA COSTA does not think that histological experiments can give any practical information.

3. A study was carried out to try and isolate the enzymes responsible for the anchovy process d to examine their effect. The work done has confirmed the enzymic nature of the process, but it is neces-ary to continue them and carry them further. (+)

IV. ANALYTICAL RESULTS

It is perhaps superfluous to reproduce in this summary the seventeen tables of analytical results btained in the experiments of the first and second series and which are contained in the original report . t will be sufficient to retain the figures relating to the tests carried out at room temperature - the only nes which resulted in the production of an acceptable quality product - and to summarise them in a single able.

In this table the figures for fat and nitrogen are based on dry weight. Those for ash on the wet eight. Total nitrogen is shown as such and was obtained by dividing by 6.25, the figures for protein given n the original report. This enabled the figures for amino nitrogen and ammoniacal nitrogen to be compared ith total nitrogen.

The amino nitrogen was obtained by deducting the ammoniacal nitrogen from the figures given in the riginal report for the total of amino nitrogen plus ammoniacal nitrogen.

Concerning these figures two things should be noted, firstly, that the fish used for the tests A. .C.D. arrived in brine from Setubal so that the figures for zero time do not correspond to the fresh fish ut to a raw material having undergone certain changes, hence the high figure for dry matter (41 %), ash 12.1 %) and no doubt also the amino nitrogen (19.4 %) and the pH (6.9). In the second place certain obvi-usly wrong figures have been omitted and replaced by question marks. Especially those dealing with the mino nitrogen of the 480th day samples, according to which, in the original report the ammoniacal nitrogen as greater than the sum of the ammoniacal nitrogen and amino nitrogen.

No estimation of chlorides is given in the original report, and the author of the present summary as tried to calculate the amount of salt absorbed and to relate this to the water content of the product. t would seem probable that on the 4th day the water would have been saturated with salt.

V. CONCLUSIONS

At this point it may be permitted to the author of the present summary to substitute himself for the ate author of the original report. Mr. Charles LEPIERRE who proposed to continue this work was in fact too odest in certain of his conclusions.

Two very important points have come out of this work :

1. the anchovy process carried out under strictly hygienic conditions, that is to say in sterile containers and using new and sterile brine, resulted in a product identical with that which is obtained under standard conditions.

   This demonstration has destroyed an old tradition according to which a certain lack of cleanliness or at least the use of old barrels and brines was indispensible to the success of the process. We, therefore, are going to be able to insist on cleanli-ness where it is not sufficiently understood, and this will be very definitely - as in the case of brined meat - to the advantage of the quality and the uniformity of the finished product.

2. Too high a temperature far from accelerating the anchovy process slows down the charac-teristic degradation of the protein material and results as well in an unacceptable product. Mr. LEPIERRE concluded that this last observation, condemned the carrying out of the process under temperature conditions other than those usually used.

   A study of temperature conditions is worth following up in order to establish on the one hand the optimum temperature and on the other hand upper and lower limits of temperature range. It might be possible that slight refrigeration during certain phases of the process or at certain seasons could improve the product and avoid certain de-fects in manufacture.

(+) The death of Professor LEPIERRE interrupted the work at this point.

EXPERIMENTS ON THE ANCHOVY PROCESS AT ROOM TEMP. (15-30°C)

Duration of process in days	Experiment No (x)	Dry matter per cent	Fat per cent of dry matter	NITROGEN: Total as per cent of dry matter	NITROGEN: Amino as per cent total N	NITROGEN: Ammoniacal as per cent total N	Ash as per cent wet matter	NaCl absorbed (calculated): Per cent wet matter	NaCl absorbed (calculated): Per cent water	pH
Zéro	I & II	36 36	16,1 19,4				3.5 2.3			5.2 6.6
	VIII	36	16,1				3.5			5.2
	A, B, C & D	- 41 ±	- 7.4 ±	- 11.1 ±	- 19.4 ±	- 0.8 ±	- 12. 1 ±			- 6.9 -
4	I	45	8.6	7.6	12.6	1.8	18.5	15.5	28.8	5.7
9 to 16	I & II	47 53	7.6 10.5	7.6 7.8	11.1 7.2	1.2 0.9	18.9 17.4			6.2 6.2
21	VIII	46	4.6	7.8	14.2	1.4	19.3			6.8
30	I & II	56 53	7.6 9.1	6.3 7.9	13.0	1.0 1,3	22.4 18.3			6.2 6.2
	VIII	47	4.9	7.6	15.0	1.8	19.5			6.2
	A, B, C & D	49 51 49 50	5.1 5.0 9.8 7.6	8.8 8.9 9.1 9.5	11.0 12.7 9,0 10.7	1.3 1.5 1.2 1.6	17.6 to 19.8			6.2 to 6.3
90	I & II	47 47	8.2 11.1	6.8 7.7	9.1 16.7	3.6 1.5	19.4 18.0			6.8 6 8
	VIII	43	9.4	7.9	19.4	2.1	17.3	15.4	29.3	6.2
	A, B, C & D	49 43 49 54	6,3 7.3 8.2 4.2	6.8 10.0 8.5 8.3	12.6 12.6 9.6 9.7	1.4 1.3 1.1 1.1	17.6 to 18.8			6.4 to 6.6
180	I & II	44 52	8,8 5,9	7.3 7.3	9.0 10.6	2,0 1.1	19.5 20.0			6.4 6.0
	A, B, C & D	50 52 50 52	5,6 4.9 9.5 5.9	9.1 8.9 8.2 8.5	13,7 15.1 15.0 15.5	1.2 3.5 6.0 1.6	18.2 to 21.1			6.1 6.2
300	I & II	53 50	9.0 9.3	7.2 7.7	9.1 14.9	21.7 19.4	23.5 19.9			7.4 7.8
	A, B, C & D	52 49 51 49	5,5 6.2 6.5 3.7	9.0 8.4 7.7 8.5	14.5 14.0 14.0 13.5	3.1 2.1 2.1 1.5	17.7 to 19.6			6.1 6.5
480	I & II	49 54	2.6 3.7	9.2 8.9		35 7.2	19.6 20.4			6.2 6.0

(x) For codes see p. 2 (+) Anchovies bought from Setubal in brine

TOTAL NITROGEN IN SOLUTION IN THE BRINE IN MILLIGRAMS PER 100 MILLILITRES OF BRINE

Experiment No	Method of treatment / Days :	0	7	15	23	60	90	120	150	150 Organoleptic character		180	180 Organoleptic appearance		210	240	240 Organoleptic character	
										Taste	Appearance		Taste	Appearance			Taste	Appearance
1	Control without adjustment of pH.	-	246	157	263	423	339	593	437	Normal	Normal	470	Normal	Colour not uniform	234	28	Good	Colour not uniform
2	pH 5.0	-	172	132	179	420	322	504	300	Normal	Normal	507	Normal	Normal	308	302	Good	Good
3	pH 6.0	-	228	171	202	394	365	434	336	Normal	Normal	339	Normal	Normal	288	347	Good	Good
4	pH 7.0	466	226	207	140	509	493	420	535	Marked	Pinkish colour	333	Marked	Colour too uniform	-	129	Very good	Very good
5	pH 8.0	448	323	185	218	420	392	210	-	Normal	Normal	462	Normal	Normal	333	356	Good	Colour not uniform
6	With 5 % yeast added to the brine without pH adjustment.	423	242	207	226	358	332	490	252	Normal	Normal	353	Marked	Colour not uniform	249	10	Good	Irregular
7	do.pH 7.0	302	270	236	274	504	389	605	451	Normal	Light red	510	Marked	Colour not uniform	395	14	Good	Irregular
8	do.pH 7.5	509	238	-	123	456	381	652	419	Normal	Whitish	532	Little character	Colour not uniform	389	409	Good	Irregular
9	Addition of 1 % of trypsine to the brine, without pH correction.	624	257	271	280	552	333	627	-	Normal	Normal	626	Normal	Normal	379	342	Good	Good
10	do.pH 7.0	401	229	266	252	594	591	588	476	Pronounced	Reddish	546	Good	Colour quite uniform	351	400	Very good	Very good *
11	do.pH 7.5	466	260	189	257	548	454	557	454	Normal	Normal	496	Normal	Normal	367	-	Good	Good
12	Addition of 2% of extract of malt to the brinewithout pH correction.	346	252	257	199	378	372	554	451	Normal	Normal	-	Normal	Not satisfactory	420	305	Poor	Colour not uniform
13	do.pH 7.0	451	224	263	168	484	330	574	661	Normal	Normal	487	Normal	Colour not uniform	302	254	Poor	Colour not uniform
14	do.pH 6.0	392	210	228	175	342	377	504	396	Normal	Normal	437	Normal	Colour quite uniform	305	280	Good	Colour not uniform
15	Addition of 1 % of pepsine to the brine, without pH correction.	388	235	232	201	430	347	560	462	Normal	Pasty	8	Feeble	Pale colour	300	311	Good	Good *
16	do.pH 4.0	-	266	305	151	479	392	496	356	Like fresh fish	Dry	67	Feeble	Pale colour	56	235	Good	Irregular
17	do.pH 6.0	341	238	243	220	489	398	521	414	Not characteristic	Dry	518	Normal	Pale colour	392	308	Good	Irregular
18	Fish in excessive brine.	22.8	30.5	39.2	47.6	57	64	70	-	Like fresh fish	White colour	43,4	Like fresh fish	White colour	63	7	Like fresh fish	White colour

* The preparations indicated by an asterisk were suitable for turning into fillets in the 240th day.

STUDIES BY J. MERCIER MARQUES

with the collaboration of Miss L. de LIMA BRITO, D. Sc., and of Miss I. M. VIANA, D. Sc.

Taking as a starting point the end of the work of Ch. LEPIERRE, and after having verified once again that apart from this work, the scientific bibliography on the process of anchovy production is almost nil, (J. MARQUES quotes a communication from F. LOPEZ - CAPONT Laboratory of Unión de Fabricantes de Galicia, Spain, and the opinion of the Provincial Laboratory of Groningen, Holland, according to which the maturation of anchovies is due to enzymic degradation of protein material with the formation of tyrosine, tryptophane and other amino acids) the author proposes to study the rate of this enzymic hydrolysis, on the one hand, at various pHs (obtained by the addition of either lactic acid or sodium carbonate) and on the other hand in the presence of enzymic substances added to the brine (Baker's yeast, trypsin, malt extract and pepsin). Finally the author has tried to see if, by placing the fish in an excess of brine, so as to dilute the natural enzymes present, the process of anchovy production could or could not take place.

The hydrolysis has been followed, not by estimation of the total nitrogen in the fish, but by the estimation of total soluble nitrogen in the brine. The estimations were carried out every seven days during the first three weeks, then at the 60th day, and then every 30 days until the 240th day. The results are expressed as milligrams of nitrogen per hundred millilitres of brine. The anchovy process was carried out according to industrial techniques in tinplate cans, containing 42 fish weighing about 500 grams.

Table given page 5 gives the complete results which the author has also expressed by graphs, these showing better the comparative rates of solubility of nitrogen in the controls and in the other experiments. However, we have not room to show these in the summary.

The first series of test (1 - 5) shows that working at pH 7 favours a more rapid solution of the nitrogen; pH 8.0 is markedly unfavourable. The results of the organoleptic examination should be also noted.

Experiments 6 - 8 (with yeast), 12 - 14 (with malt extract), and 15 - 17 (with pepsin), show that these additions have no accelerating effect on the solution of nitrogen. On the other hand, tests 9 - 12 show that the addition of trypsin accelerates the solution of nitrogen at pH 7, and also when the pH is not adjusted. In an alkaline medium the action is less rapid. The results appear to confirm the opinion of the Groningen Laboratory already quoted, according to whom the anchovy process is a tryptic digestion of the nitrogenous material.

The last experiment (18) is very instructive, since it shows quite well that if the active biochemical substances produced during the anchovy process are diluted in an excess of brine, the process does not continue. During the experiments described, the author has not observed any visible microbial action, even though no special precautions to avoid them were taken. According to the remarks of certain observers, putrefaction of anchovies during manufacture may occur through negligence in the regular addition of brine or when the compression is insufficient, thus allowing pockets of air to remain between the fish.

The confirmed absence of bacterial growth, and the fact that the best results both from the point of view of the speed of solution of nitrogen as well as in the development of organoleptic characteristics has been obtained at pH 7 with the addition of trypsin, makes the author consider that tryptic digestion does play a preponderant role in anchovy production, and he concludes that the industrial operation could be made more effective and more uniform if it were carried out at a controlled pH and if it were helped by the addition of the appropriate enzymes. These results have led J. MARQUES to consider following up his work in order to throw some light on the following points.

1. The influence of temperatures between 20° and 30° :
   a) on normal anchovy production without adjustment of pH;
   b) on normal anchovy production at various pHs;
   c) on anchovy production with the addition of trypsin at constant pH.

2. The influence of salts which might increase the action of the trypsin.

XXXVI. THE BACTERIOLOGICAL EXAMINATION OF CANNED HAMS

by R. BUTTIAUX

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Canned hams are numerically the largest group of pasteurised meat products. They are pasteurised, not retorted, and more often than not are unsterile. Their bacteriological examination is, therefore, most important in estimating their hygienic quality, but it is relatively difficult, since it is necessary not only to determine the quantities of micro-organisms present in the sample, but above all, to classify them. The examination should distinguish and identify :

1). organisms pathogenic to man;
2). those which are capable of altering the keeping properties of the product;
3). common saprophytic organisms which may be tolerated in pasteurised meat products.

The procedure of the bacteriological examination depends directly on the nature of the various infections which may contaminate the product during the manufacture of the ham , and we will therefore rapidly describe them.

I. BACTERIAL CONTAMINATIONS OCCURRING DURING THE MANUFACTURE OF CANNED HAMS

1. The ham after slaughter

The meat of a healthy, resting and fasting animal is sterile. It is not so when the pig is killed during the period of digestion. At this time, there is a normal bacterial flora, which may be found in muscles of organisms normally occurring in the intestines. Those most frequently found are the Clostridia (Cl. perfringens particularly, Cl. botulinum sometimes) or the Enterobacteriaceae (Escherichia coli or Paracolobactrum). GIBBONS and ROSE (1) have shown, on the other hand, that the meat of a resting pig had a pH which dropped rapidly to 5.3 after death. This is due to the breakdown of glycogen to lactic acid, and tends to neutralise the effect of the post mortem microbial changes. It is the same in active pigs where the pH of the meat is about 6 rising even to 6.6 a little time after slaughter. It goes without saying that only

NOTA. Figures between ( ) refer to Bibliography, p. XXXVI - 7.

the meat of a healthy animal is really sterile. However, one may find human pathogens in the meat of animals which are not sick, but are merely carriers. Recent work has shown that under these conditions, the pig often harbours Salmonella. We have (2) drawn attention to this important question after some other authorities (3, 4). It must be remembered that meat passed as healthy after careful macroscopic veterinary examination may still be contaminated by Salmonella. The bacteriologist must therefore pay particular attention in looking for them in pasteurised canned pork. The cutting up, jointing and handling if carried out without abnormal delay involve little risk of infecting the ham. Fresh meat, in fact, possesses a normal bactericidal power, sufficient to prevent a microbial invasion. It is evident, however, that contamination should be kept to a minimum. The cleanliness of equipment and tables is an important factor in the final quality of the product, and it is even more important during the canning operation.

2. The ham during brining

All depends on the quality of the brine. There is no good canned ham without a perfect brine. In an active clean brine, the microbial flora consists almost exclusively of Micrococcaceae (Micrococcus nitrificans predominating) and Achromobacter (Achromobacter liquefaciens especially). These two species are very numerous and accompanied by some of the few bacilli (B. subtilis B. cereus) and rarely by some Clostridia. In a brine of a bad bacterial quality one finds on the contrary as well as Micrococcaceae and Achromobacter a large number of Bacillaceae and especially Enterobacteriaceae (Eschericheae, Proteae). This question is sufficiently well known not to need stressing and has been well studied by RIVIERE (5) and JONES (6) in particular.

Cooking after brining will remove nearly all non heat resistant bacteriae but will have practically no effect on the spores of the heat resistant bacilli or at least on those in the deeper layers of the ham. In certain factories vegetable spices, such as laurel leaves, clover, peppercorns, etc.., are added to the brines or cooking water, and these products are capable of infecting the surface of the meat with relatively large numbers of spore forming mesophilic or thermophilic bacilli. HALL et al. (7) and BILIJANSKY (8) have shown that these spices normally carry large numbers of these organisms, and it is, therefore, preferable to avoid them by using essential oils and essences which may be prepared in the factory itself by maceration and distillation.

3. The ham during packing

During this operation, the greatest and most dangerous contaminations may occur. They may come from:

a) the can itself

It is useful, if not essential to sterilise the internal surface of the can before filling it. This is done by superheated steam, by flaming, or by exposure to ultra-violet light. In fact, dust inside cans normally contains a large number of bacterial spores.

b) the gelatine

In many cases which we have studied, we have found that the infection in canned hams comes from jellies of poor bacteriological quality. They sometimes contain an unbelievable number of types of micro-organisms - Enterobacteriaceae, Micrococcaceae, Lactobacteriaceae, Bacillus and Clostridium. The cleanliness, or rather the sterility of the gelatine is a major point on which the bacteriological quality of the final product closely depends.

c) the operators

These may carry to the contents of the can, saprophytes or pathogenic organisms. These latter are the most important and bring up the question of " carriers " who are met with much more frequently than one might imagine in the food industry. The most to be feared as far as pasteurised canned meats are concerned are carriers of Salmonella and enterotoxic staphylococci.

4. The ham during pasteurisation

The percentage of vegetative forms and microbial spores which are destroyed depends on :

- their greater or lesser thermal resistance;
- the temperature obtained;
- the time of heating;
- the pH of the product.

These factors are well known and need not be stressed and it will be realised that the final product will contain very few organisms if the following conditions have been obtained :

- the microbial infection kept as low as possible initially;
- the pH less than 6 and if possible between 5.5 and 5.8;
- the temperature held at 100°C at least at the surface for 20 minutes and followed by heating at 85° to 90°C for the sufficient time which depends on the volume of the hams.

5. The ham during cooling

Cooling should be as rapid as possible after pasteurising. This is the only way to avoid a marked rowth of thermophilic bacilli. It must be carried out on perfectly sealed cans, the smallest leak being rom this moment of major importance. It is generally admitted in America that it is impossible to obtain completely hermetically sealed can, but we think this opinion rather exaggerated, although frequently quite ustified. Contamination during cooling may be avoided by using clean water properly chlorinated.

We have discussed in this preamble only whole hams with rind and fat. It will be agreed that the reparation of sliced ham always involves a marked microbial infection of the product before pasteurisation. qually the preparation of small hams is often more difficult from the bacteriological point of view and one ust take care that the bladders which are sometimes used to wrap them are properly and carefully cleaned.

. VARIOUS BACTERIOLOGICAL ASPECTS OF CANNED HAMS

According as to whether or not the rules of manufacture and the principal precautions pointed out n the previous chapter have been followed, a good or bad quality product will be obtained. We will now desribe systematically the results generally given by a bacteriological examination of these various hams.

I. Canned hams of a good bacteriological quality

a) What does sometimes happen is that the contents of the can are sterile and in our experience his has occurred in thirty per cent of the cans examined. The number of dead organisms in direct smears is mall.

b) What normally occurs - the production is unsterile but the viable organisms which may be grown n a suitable medium are few - (1 to 10 per 1 g of sample). The numbers of dead organisms found in stained mears are few - (one in three, four or five microscopic fields with an immersion objective). The organisms solated belong nearly always to the following families :

- Bacillaceae :
  - -- Mesophillic or facultive thermophilic Bacilli.
    B. subtilis, B. cereus are the most frequent and
    B. pumilus, B. coagulans, B. sphaericus are rarer.
  - -- Thermophilic Bacilli :
    B. thermoamylolyticus, B. thermoindifferens, B. thermodiastaticus, B. calidolactis, are very frequent.
- Lactobacteriaceae :
  - -- Streptococcus faecalis,
  - -- Streptococcus thermophilis.

We have hardly ever found Clostridia or other strict anaerobes in canned hams which have not shown signs of change during prolonged storage. However, in two cases out or more than 600 which were examined, we have isolated Inflabilis (Prevot) which have been completely tolerated.

2. Dangerous bacterial contamination in canned hams

From the point of view of public health, they may be divided into two categories :

a) organisms which are pathogenic to man or which produce toxins;

b) organisms capable of rapidly altering the quality of the product.

a) Pathogenic organisme ans their toxins

1). The most important of these is Clostridium botulinum and the botulinus toxin. Although this is found fairly frequently in raw hams prepared by individuals, it appears to be rare in cooked canned hams. We have never found it, and we know of no record of its occurrence. However, botulism is still the greatest danger in pasteurised canned meat products, and all the efforts of the bacteriologist should bear on a systematic search for this Clostridium and its toxin.

2). The Salmonella are always possible contaminants. They are carried to pasteurised pork products either in the meat itself, as we have described, or by carriers. Their occurrence is not very frequent, and pasteurisation has obviously a marked effect on these non-heat resistant organisms. We have found S. typhimurium in a sample of small ham.

3). Enterotoxic Staphylococci. These nearly always come from skin lesions of the workers who prepare the ham and some of them may be slightly heat resistant which makes them more difficult to destroy during pasteurisation.

b) Organisms producing a change in the product and sometimes capable of making its consumption dangerous

1). The Bacilli although in the majority of cases these are completely tolerated, certain types exist which can make the can blow. JENSEN, WOOD and JANSEN drew attention to this in 1941, and it was recognised that by an anomaly in their metabolism these bacilli produced large quantities of CO_2 by fermentation of sugars. GIBSON in 1943 showed that this process could be carried out in vitro by culturing them in neutral or alkaline medium containing a large quantity of a fermentable sugar and nitrate. VERHOEVEN (9) has shown more recently that marked swelling may be produced in canned ham without any sign of putrefaction by a spore forming bacillus which is a powerful nitrate reducer. In this case, N_2 and N_2O are more prevalent than CO_2. It should not be forgotten, on the other hand, that B. polymyxa is able in some cases to ferment sugars with gas production. Among the thermophiles, we have seen one batch of swelled hams, due to B. michaelisii. This gives a rapid reduction of nitrate with the production of gaseous nitrogen. Generally the thermophilic bacilli are without any obvious action on canned meats stored at less than 30°C. and we have checked this by a large number of experimental inoculations.

2). The Clostridia. These are responsible for nearly all changes occurring in canned hams, particularly those causing swelling. Three types most frequently found are :

Cl. perfringens;

Cl. sporogenes;

Cl. bifermentans.

One can also find anaerobic thermophiles which are facultative or obligate. They are not very harmful at normal storage temperatures, but may become so in warm countries. Their bacteriological study is still incomplete, and we cannot with certainty identify those which we have so far been able to isolate.

In all cases the Clostridia are found in badly prepared products. The source is assumed to be infected meat or meat coming from animals slaughtered too long before brining, preparation with dirty utensils or equipment, bad quality brines or heavily infected gelatine. Pasteurisation does not destroy the spores of the Clostridia an their great heat resistance is well known, especially that of Cl. sporogenes; V. ASCHEHOUG and JANSEN have again drawn attention to this (10).

3). The Enterobacteriaceae (other than Salmonella). These should never be found in canned hams, but those which occasionally infect then belong mostly to :

Escherichia (Escherichia coli, Escherichia intermedium, Escherichia freundii);

Klebsiella (Aerobacter aerogenes or cloacae);

B. paracoli aerogenes (also known as Paracolobactrum) or anaerogenes;

Proteae (Proteus vulgaris or mirabilis).

These always produce marked swelling of the cans, and their presence is due to the same mistakes as those pointed out for Clostridia.

Clostridia and Enterobacteriaceae make the hams inedible. They produce a putrid small and a marked proteolysis; the contents of the can may be toxic both to man and to animals.

4). Lactobacteriaceae. We have found that there occurs fairly frequently in pasteurized canned meats of good bacteriological quality, e.g. Streptococcus faecalis (Enterococcus). Their presence is not dangerous. DACK and his collaborators (11) have shown that large numbers of these organisms taken by human volunteers produce no pathological symptoms. They do not change the appearance or the edibility of the product, as we have frequently verified. On the other hand, Streptococcus liquefaciens, an aerobe or facultative anaerobe, is capable of producing slow but marked liquefaction of jelly. We have found several contaminations by this streptococcus and it should be prevented.

III. THE BACTERIOLOGICAL EXAMINATION OF CANNED HAMS

We have chosen as a typical examination, one which enables to be shown in the most rapid, obvious and simple manner, the various types of microbial contaminants described above. We have used this method for nearly four years at the Food Hygiene Service of the Pasteur Institute at Lille, and it has always given complete satisfaction. We think it useful, therefore, to describe here the technique selected from a large number of others which we have tried.

1). The can is incubated at 40° Cent. for 24 hours. It is placed in the incubator with the rind side uppermost so that the gelatine while melting will wash the opposite surface of the ham and the organisms in the meat can reach this quickly and develop. Every can showing swelling, after the incubation, is of bad bacteriological quality. On the other hand, the unswelled cans are not necessarily of good quality. At this time, small leaks in the can should be looked for with the greatest care.

2). After sterilising the side of the can opposite to the rind, two holes are made in it :

a) a lateral one which is used to remove with a 20 cc sterile Pasteur pipette, at least some melted gelatine;

b) a central one through which is removed a fairly large cylinder of meat. This should be taken from the whole height of the ham. The gelatine and meat are then placed in a sterile mortar and coarsely mixed. There should be a total of about 30 grams.

3). The mixture of meat and gelatine inoculated in the following way :

a) about 2 cc in each of two tubes (22 x 22) of Rosenow medium. Their surface is covered with a layer of sterile melted paraffin about 1 cc thick;

b) about 2 ccs in each of two tubes (20 x 20) of sodium thioglycolate medium;

c) about 2 ccs in each of two tubes (20 x 20) of tryptose (Difco) broth;

d) about 5 ccs in a (20 x 20) tube of acid sodium selenite medium;

e) 6 to 7 drops on the surface of some Chapman's medium run into a Petri dish.

4). One tube of Rosenow medium, one tube of thioglycolate medium, one of tryptose broth, one of selenite and the Petri dish of Chapman's medium are incubated at 37°C.

5). One tube of Rosenow medium, one of thioglycolate and one of tryptose broth, the latter two having previously been sealed, are incubated at 55°C.

6). The Rosenow, thioglycolate and tryptose broth tubes are examined every 24 hours.

Growth is shown on the former by a change to pink or bright red (organisms fermenting glucose) with or without gas production which lifts the paraffin wax plug, or by the appearance of turbidity (non glucidolytic organisms).

The tryptose or thioglycolate media shown growth by the presence of a small or a marked cloud or by floculation. As soon as microbial growth is suspected in one or other of the tubes, a Gram stained smear of the culture is made. The organisms are then seperated by culture onto solid media : tryptose agar aerobically and gelatine-agar or V.F. agar medium anaerobically. They are incubated at 37° or 55°C according to the temperature at which the original growth occurred.

7). After 48 hours at 37°C a loopfull from the selenite medium is streaked onto plates of S.S. agar (Difco) or desoxycholate-citrate-lactose agar. These are incubated at 37°C and examined 24 hours later. All suspected colonies (whitish colonies with or without a black centre) are subcultured onto the quick diagnostic medium of Kliger or Hajna.

8). The Chapman medium is examined after 48 hours at 37°C. The colonies having the appearance of Staphylococci and which ferment mannitose (a yellow ring) are subcultured onto ordinary nutrient agar which is again incubated at 37°C.

9). The successive isolations from the solid media inoculated from the Rosenow thioglycolate or tryptose medium are carried out by the usual aerobic or anaerobic techniques. The organisms isolated are then identified.

10). The biochemical and antigenic properties which allow of the identification of Salmonella and other Enterobacteriaceae are looked for on the subcultures onto the Kliger or Hajna medium.

11). On the Staphylococci rapid tests for toxicity should be carried out - coagulase, haemolysis, or fermentation of mannitol. It takes too long and is too complicated in normal routine work to look for enterotoxins. In fact, we usually inoculate guinea pigs subcutaneously with about 2 ccs of the mixture of gelatine and meat. This is the only rapid and certain method of demonstrating the presence of botulinus toxin in the food examined.

I. Advantages of the culture media chosen

All the media used in this analysis are known to bacteriologists. We will describe, however, some of their advantages in food bacteriology. Rosenow medium (12) described in 1919 is still, in our opinion, one of the best for the development of all aerobic and anaerobic bacteria which are difficult to grow when first put into artificial media. Like thioglycolate broth, it produces at the same time conditions which are both sufficiently aerobic and anaerobic. The use of these two media therefore does away with the complicated apparatus previously used for the culture of strict anaerobics. It is known that in the differential diagnosis of numerous types of bacilli, the position and the shape of the spores has great importance. We also know how slowly these latter sometimes develop from the vegetative forms. We have noticed for a number of years without publishing it that all the bacilli form spores with great rapidity on tryptose media, a peptone prepared by the Difco Laboratories (Detroit, Michigan, U.S.A.). That is why we recommend its use in the examination of canned hams where bacilli are so often found.

Acid sodium selenite and Muller-Kauffmann media are designed for the enrichment of Salmonella in faecal materials or other products containing large numbers of bacterial types. Like S.S. agar and desoxycholate - citrate - lactose agar they sharply inhibit the growth of lactose fermenting Enterobacteriaceae (particularly Escherichia) and completely that of all Gram positive organisms. Their value in this connection will be understood. We have, however, completely given up the use of Muller-Kauffmann medium with sodium tetrathionate for identifying Salmonella in food products. It gives a much smaller percentage of success than does the selenite medium. We are, on this point, in agreement with CRUIKSHANK and SMITH (13) that the use of selenite, or S.S. agar, and of desoxycholate-citrate-lactose agar will almost certainly reveal every Salmonella existing in a foodstuff. Their rapid identification, however, necessitates the use of rather special techniques which we have described in detail elsewhere (14).

Chapman's medium contains 75 grams per 1,000 of Na Cl - this makes it suitable for the culture of halophilic organisms of which the staphylococcus is one of the principal. It inhibits the growth of all the Enterobacteria but unhappily it permits the growth of large numbers of types of Bacillaceae. We have described elsewhere, however, its different applications in food bacteriology (15 and 16).

2. Formulae and preparation of the principal media used.

1) Rosenow's medium (for aerobic and anaerobic culture) :

Tap water	1000 cc
Peptone (Trypsin digest)	10 g
Liebig's extract	3 g
Na Cl	5 g
Glucose	2 g
Andrade's indicator	10 cc

Mix the water with the peptone, the salt and Liebig extract, dissolve by boiling for some minutes, adjust to pH 7.2, boil in fresh water and filter, add Andrade's indicator :

Acid fuchsin	0.5 g
Distilled water	100. cc

If the pH of the glucose is right, the liquid is pale pink; if the pH is too low, the liquid is bright red, and it should be adjusted in this case by the addition of very dilute soda. Place in 22 by 22 tubes about 20 cc. in each tube, in which has first been placed one small bit of white marble and one small piece of beef or sheep brains, first hardened in cold store, and from which the meninges and superficial blood vessels have been removed. Sterilise in an autoclave for 20 minutes at 115°C.

Annex - Paraffin wax (melting point 50/55°C); 20 cc for a 20 by 20 or 22 by 22 tube, closed with cotton wool, sterilised for 20 minutes at 120°C in the autoclave.

2) Thioglycolate medium (modified Brewer formula) - (for aerobic and anaerobic culture) :

Meat broth (not peptised)	1000 cc
Extract of yeast	5 g
Peptone (Trypsin digest)	10 g
Na Cl	5 g
$K_2 HPO_4$	2 g
Glucose	5 g
Powdered agar	1 g
Sodium thioglycolate	0.5 g
Methylene blue	0.002 g

Dissolve by gentle heating, adjust to pH 7.2, and filter hot. Put into 20 by 20 tubes with a depth of at least 10 centimeters of medium in each tube. Sterilise for 15 minutes at 120°C. The methylene blue colours green the upper aerobic zone of the tube but this should not have a depth of more than 2 cm.

Important note. If the Rosenow or the thioglycolate medium are not used the same day as they are made, they must ne regenerated before inoculation. This can be done by putting them for 5 to 10 minutes in a boiling water bath. They are rapidly cooled in water under the tap.

3) Tryptose medium

Liebig's extract of meat	3 g
Tryptose (Difco)	10 g
Na Cl	5 g
Glucose	4 g
Water	1000 cc

Dissolve, adjust to pH 7.2, boil and filter, fill into 20 by 20 tubes. Sterilise for 15 minutes at 120°C. A nutritive tryptose agar may be obtained by adding to the above broth 15 grams of powdered agar per 1,000.

4) Acid sodium selenite medium

Sodium selenite	4 g
Peptone (Trypsin digest)	5 g
Bisodium phosphate	10 g
Lactose	4 g
Distilled water	1000 cc

Dissolve by gentle heating, put into 20 by 20 tubes so as to have a depth of medium of at least 12 centimeters. Sterilise by heating in steam at atmospheric pressure for 30 minutes - never autoclave - store preferably at 4°C. (when it may be used over several months) or at room temperature in the dark. Samples inoculated into this medium should be well emulsified.

The Salmonella grow particularly in the deeper layers and it is at this level thar the loop for sub-cultures onto selective media must be.

5) S.S. agar

This medium is prepared in dehydrated form by the Difco Laboratories (Detroit, Michigan, U.S.A.).

It may be replaced by desoxycholate-citrate-lactose agar whose method of preparation may be found in any modern text-book on bacteriology or in one of our publications (14).

6) Chapman's medium

Its formula can be found in any recent work on bacteriology. It is also to be found in some of our previous publications (16).

IV. CONCLUSION

The manufacture of canned ham necessitates the strict observation of certain indispensable precautions in order to produce an article of good bacterial quality. Like all pasteurised canned meats, it may be contaminated by numerous and varied organisms.

The type of bacteriological examination which we suggest may appear complicated, but it has the merit of showing up in every case and without possibility of error, pathological organisms, and all those which might cause changes in the canned product. In every microbiological study applied to food hygiene, we think that the two fundamental rules of general bacteriology must not be disregarded; isolation and identification of the causative organism.

That is why we have systematically abandoned the much simpler examination for putrefactive, indologenic and proteolytic organisms. We do not deny its use but the interpretation of their presence in pasteurised canned meats too often leads to grave errors. A complete bacteriological study is not only of major interest in public health control, but it also enables valuable service to be given to the manufacture. The identification of any spoilage organism leads to the source of the contamination and to know this is the most certain way of rapidly removing it.

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XXXVII. NON-ENZYMATIC BROWNING

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I. INTRODUCTION

When goods are cooked in the home, processed in the factory, or stored for considerable periods between preparation and consumption chemical interaction between the constituents is liable to occur leading to marked changes in the physical and chemical properties of the food. Among the properties most likely to be affected are those of colour, odour, flavour, texture, solubility and, in less degree, nutritive value. When a darkening in colour of the product is a conspicuous feature of the change, the chemical reactions responsible have come to be referred to as "the browning reaction" or - to distinguish them from the enzymic browning of damaged tissues of fresh fruits and vegetables - as "non-enzymatic browning". It should be realised, however, that the reactions grouped together in this way are very complex, and can vary widely with the chemical composition of the food and the conditions of processing and storage.

II. BROWNING REACTIONS CAN PRODUCE DESIRABLE OR UNDESIRABLE RESULTS

Empirical use of reactions of the browning type is made every day, both in the traditional methods of food preparation and cooking and in the modern food processing factory, where we modify the natural flavours, textures and colours of raw food materials such as flesh, milk, cereals, fruits and vegetables to fit them more closely to our liking. Many of the changes produced by heat sterilization, concentration, drying or salting, or by subsequent storage of the stabilised product are, however, more or less incidental consequences of the means adopted for the prevention of microbial or enzymic spoilage, and their effects on acceptability of the food are as likely to be disadvantageous as otherwise. It is for this reason that the food scientist in the past has had to concern himself mainly with the deteriorative aspects of non-enzymatic browning. Some attempt, however, is at last being made to produce desirable food flavour experimentally by the controlled interaction of known constituents of food, particularly individual amino acids, amino acid fractions of protein hydrolysates, or proteins, with individual sugars or carbohydrate- rich foods. With glucose as the sugar, glycine, for example, is said to give a product with an aroma resembling beer, and leucine one with the aroma of bread, while α-aminobutyric acid apparently gives an odour strongly suggestive of maple. Very little on this aspect of the browning reactions has yet been published, although a considerable amount of work is probably going on in research laboratories.

III. CONDITIONS UNDER WHICH DETERIORATIVE BROWNING DEVELOPS

Trouble attributable to non-enzymatic browning is liable to develop either rapidly during the heat treatment involved in cooking or sterilization, or more slowly during a period of storage prior to consumption. Only those foods which are naturally resistant to microbial and enzymic spoilage, or which have been stabilised against these changes by sterilization, drying, salting, or other means are likely to be kept long enough to be affected by non-enzymic browning during storage. The deteriorative reactions proceed most rapidly when the reactants - which are often very minor constituents of the food - are present in concentrated aqueous solution, and for this reason browning is much more prevalent in concentrated or in dried than in fresh foods. A certain amount of moisture however is essential, and a dried product allowed to equilibrate with a moist atmosphere offers nearly optimal conditions for deterioration of this type. The temperature coefficients of the chemical reactions involved are invariably high, and trouble may therefore be experienced in the tropics with materials which store reasonably satisfactorily in temperate climates; conversely, browning is rarely if ever troublesome under chilled or frozen conditions of storage. Atmospheric oxygen is not essential for discoloration although in some cases it accelerates the process considerably. Oxygen may however modify certain consequences of the reaction such as the kind of " off " flavour produced and the amount of carbon dioxide evolved. Canning or packing in inert gas cannot therefore be relied on for prevention.

IV. SYMPTOMS OF NON-ENZYMATIC BROWNING

While the results of reactions of the browning type vary considerably from one food to another, deleterious changes may include any of the following;- development of a brown discoloration ranging from a pale cream or biscuit shade to almost black; production of stale, caramelized, bitter or otherwise unpleasant odour and flavour; loss of solubility of the protein leading to a deterioration in texture and to a failure of dried foods to reconstitue properly with water; a reduction of pH and frequently a production of carbon dioxide and water; enhanced reducing properties leading to interference with the estimation of ascorbic acid with 2,6-dichlorophenolindophenol and of reducing sugars by the cuprometric and ferricyanide methods, and with dye-reduction tests for bacteriological quality; an increased tendency to froth or foam; the development of the property of fluorescing in ultra-violet light, and last but not least, a loss of nutritive value of the protein resulting from a reduced availability of certain of the essential amino acids, and a destruction of ascorbic acid, when present.

V. NATURE OF THE CONSTITUENTS OF FOODS CONCERNED IN BROWNING

Most of the carbohydrate constituents of food will form brown caramelization products by a complicated process of dehydration and polymerization if heated sufficiently strongly, reducing sugars such as glucose and fructose decomposing more readily than sucrose and starch, and glucuronic and galacturonic acids more easily still. These reactions can be accelerated by acid or alkali, by organic hydroxy acids, and by nitrogenous substances, particularly amino compounds; and then proceed extensively at much lower temperatures. In some foods such as molasses or honey the amounts of non - carbohydrate materials involved may be so small that the browning reaction appears to be little more than a catalysed caramelization of sugar. In fruits and vegetables, organic acids such as citric and ascorbic may take part in complicated interactions with reducing sugars and amino acids, while in protein-rich foods such as fish and egg-white comparatively minor proportions of carbohydrate are able to produce serious changes in the proteins which constitute the major part of the food. Finally, in dried egg yolk traces of glucose have recently been shown to react with the lipid amino groups of cephalin with a resulting serious deterioration in palatability and colour.

VI. BROWNING IN INDIVIDUAL FOODS

In giving a very brief account of scientific investigations of browning in a few individual foods, it will be convenient to commence with certain of the high protein foods in which the amino-aldehyde reaction is known to play a major part in deterioration, and to proceed thence to high carbohydrate-low protein foods in which other mechanisms of browning probably contribute largely. Many of the foods mentioned will be of the dried or concentrated type, partly because - as already pointed out - browning is greatly favoured by increasing the concentration of the reactants in the aqueous phase, and partly because it was the serious deterioration in foods of this type under war conditions in hot, moist climates which led to intensive research into the mechanism of spoilage and to most of our present knowledge of the subject.

1. Milk products

The fat free solids of milk consist mainly of a mixture of protein and lactose in the proportion of approximately 2/3 by weight, and symptoms of a browning reaction (although not necessarily a marked discoloration) are liable to develop during the preparation and storage of both dried and condensed milks.

While the theory of catalyzed caramelization of the lactose, followed by physical adsorption on to the protein has had its supporters, evidence has recently been accumulating, from experiments both with milk powder (2, 3) and with casein-glucose " model " systems (4), which show that in the powder at least a

NOTA : Figures between ( ) refer to Bibliography, page XXXVII - 8.

stoichiometric reaction between the reducing sugar and the free amino groups of the protein occurs, with the production of a protein-sugar complex which is still soluble and uncoloured, but which subsequently darkens and becomes insoluble.

The free amino groups of most proteins are largely the terminal amino groups of the lysine side chains, and analysis confirms that the lysine has in fact combined chemically with the sugar. Subsequently other amino acids such as arginine and histidine also react with sugar and, since these are all essential for normal growth of the young animal, a marked deterioration in nutritive value can ultimately result.

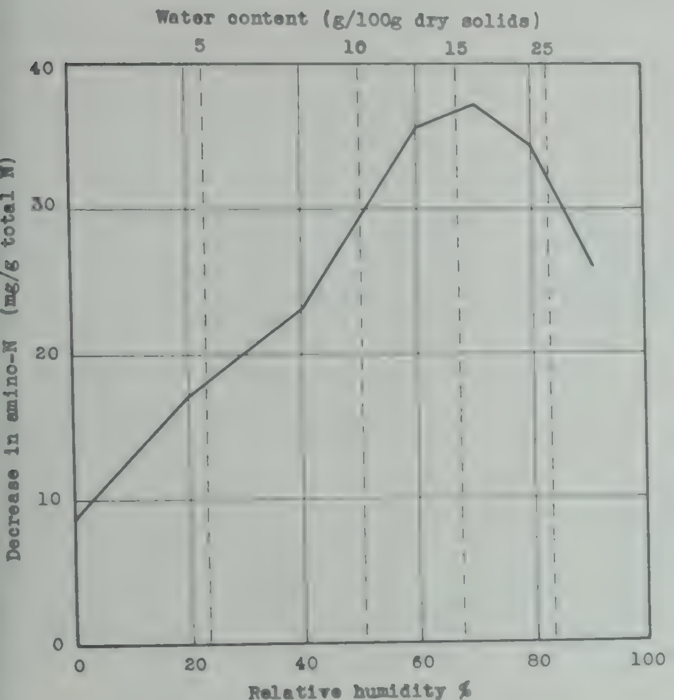

Fig. 1. Relation between activity of water and loss of free amino-N in a casein-glucose mixture after storage at pH 6.3 and 37°C.

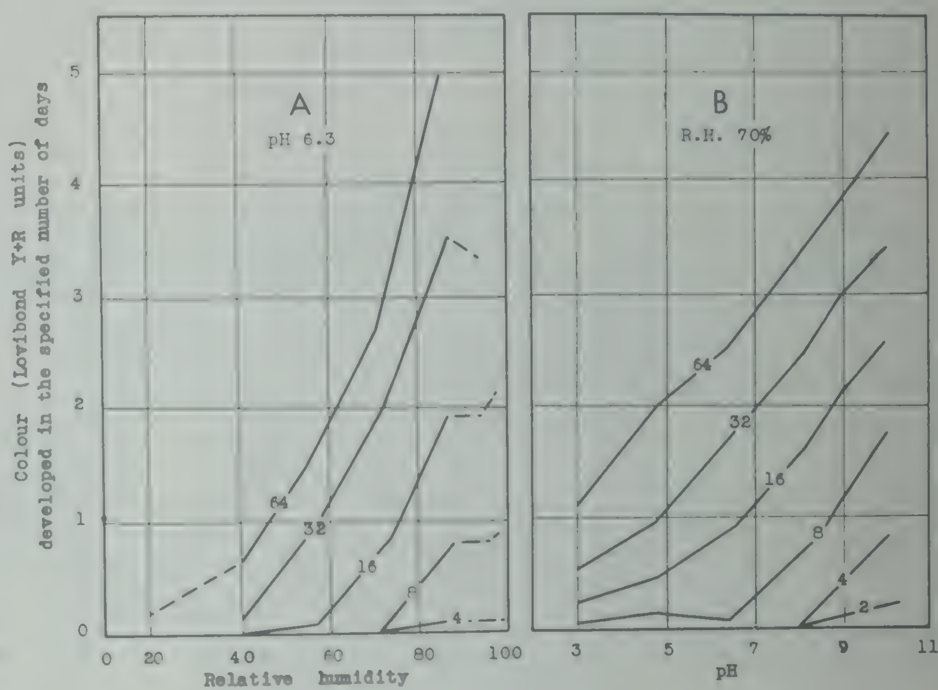

Fig. 2. The effect of the activity of water and of pH on the development of colour in casein-glucose at 37°C.

An outstanding feature of the reaction between casein and glucose is the fact that the primary combination of the protein amino groups with the sugar proceeds most rapidly in the moist solid in equilibrium with a relative humidity of 65-70 %, corresponding to a moisture content of about 15 % (fig. 1). The rate of browning, however, still increases up to at least 85 % relative humidity (fig. 2). Under optimum conditions half of the lysine side chains of casein will combine with glucose in as little as 3 days at 37°C, and in perhaps two or three minutes at 100°C. In aqueous solution and in the dry solid the reaction is very much slower, and in sufficiently carefully dried systems probably stops completely.

Other characteristics of the amino group - sugar reaction were found to be an increasing rate of reaction with increasing pH and a high temperature coefficient, the rate varying exponentially with the reciprocal of the absolute temperature and increasing by more than 5 times for an increase in temperature of 10°C.

TABLE I

Effect of sterilizing at 5 lb. pressure for 15 minutes on the discoloration of sugars, of proteins, and of sugar-protein mixtures (6)

Solute	pH		Colour after sterilization
	Before sterilization	After sterilization	
50 % sucrose	6.27	5.93	None
25 % lactose	5.95	5.35	"
50 % glucose	6.30	4.95	"
Dialysed casein	6.75	-	"
Skim milk	6.75	6.60	Slight tan
Skim milk + 25 % sucrose	6.60	6.45	Slight tan
Skim milk + 25 % lactose	6.55	6.30	Marked yellow - brown
Skim milk + 25 % glucose	6.55	6.15	Dark brown
Dialysed casein + 25 % glucose	6.50	5.10	Dark brown

Dried whey discolours on storage more rapidly and extensively than dried milk, possibly owing to the presence of protein decomposition products containing free amino groups.

Few quantitative data are available for condensed milk, but it is well known that evaporated (unsweetened) milk tends to darken in colour and to develop a caramelized flavour during sterilization, which is usually carried out by heating at approximately 117°C. for 15 minutes. Browning, the development of fluorescence and an evolution of carbon dioxide appear to be closely associated changes in the sterilization of evaporated milk, and recent work suggests that high temperature - short time sterilization at 124 - 130°C should produce a product of improved colour and flavour (5). Table I (p. 3) shows the effect of sterilizing temperatures on the development of colour in various mixtures of proteins and sugars. Sodium bisulphite entirely prevents the discoloration.

2. Dried egg

Dried egg is a food of particular interest from the point of view of the browning reaction because two distinct processes, both of the browning type and leading to deterioration respectively in the white and in the yolk, are known to occur during storage or if the product is overheated during preparation. Dried whole egg develops an unpleasant flavour, a brownish colour, insolubility, loss of aerating power, and the property of fluorescing in ultra-violet light. Chemically, its free amino-nitrogen content falls and there is a reduction in pH and in the small proportion of glucose present, which accounts initially for about 1 % of the total solids. These changes are extremely sensitive to pH, moisture content and storage temperature in a manner characteristic of the amino-aldehyde or protein-sugar reaction. Even at as low a temperature as 20°C and a water content of 4-5 % a marked loss of palatability, solubility and aerating power occurs within 4 months, and at higher temperatures or moisture contents deterioration is much more rapid.

Dried egg white, on a moisture-free basis, contains about 83 % protein and 3 % glucose, and is used commercially by the baking industry. It has long been known that bacterial fermentation of the liquid white before drying greatly stabilises the product against denaturation and discoloration during storage. STEWART and KLINE (7) in 1941 showed that stabilization was due to removal of the sugar present in the white, and STEWART, BEST and LOWE (8) removed the sugar present in whole egg by bacterial fermentation with Pseudomonas and obtained considerably increased stability. More recently yeast has been employed for this purpose both in Great Britain (9, 10) and in the U.S.A. (11), and Notatin, the specific glucose oxidase obtained from the mould Penicillium notatum, has also been used.

Two other processes have been devised for increasing the storage life of dried egg and particularly its resistance to high storage temperatures. One consists in drying to very low moisture contents, usually by a two-stage drying process. The other consists in reducing the pH of the egg pulp before drying from its normal value of about 8.5 or 9.0 (which is very favourable for the Maillard reaction) to a figure of 5.5 or 6.0; a greater reduction is not permissible since it alters the flavour of the unstored egg. After drying sodium bicarbonate must be admixed with the dried egg to neutralise the excess acid on reconstitution.

The onset of insolubility in dried egg can be delayed by the addition before drying of free amino acids, which compete with the protein for the glucose, but with the exception of cysteine these all have the disadvantage that the flavour and colour of their reaction products with sugar exceed those in the untreated egg. The addition of 10-15% of lactose or of sucrose to egg pulp before drying largely prevents loss of solubility and aerating power during storage (12), and "sugar-dried egg" has been produced on a considerable scale for use by the baking industry.

A recent development in the dried egg story has been the discovery by American workers of a new type of browning reaction involving the free amino group of the cephalin fraction of the phospholipins of the yolk (13). This change, which results in increased absorption in the ultra-violet, and visible darkening of the phospholipin fraction of the yolk, as well as in the development of ether - soluble fluorescent substances, was found to be responsible for most of the "off" flavour developed in dried whole egg during storage. It was also shown that the deteriorative changes in the phospholipin fraction of dried egg could be practically eliminated by removal of glucose from the pulp by fermentation before drying. It seems, therefore, that the small amount of glucose present in fresh egg is responsible for practically all of the deterioration in stored dried egg, browning and fluorescence being produced by reaction with both protein and phospholipin, insolubility by reaction with the protein, and "off" flavour mainly by reaction with the phospholipin. The glucose - phospholipin reaction has a high temperature coefficient like the glucose - protein reaction, but seems to be very much less dependent on the moisture content of the powder. Biochemical factors influencing the self life of dried egg have been reviewed by LIGHTBODY and FEVOLD (14).

3. Canned, dried and salted fish

Reports of browning in flesh foods, which contain very little carbohydrate, have been rare, but attention has recently been directed to the occurence of reactions of this type in canned, dried and salted fish. Samples of canned, white-fleshed fish are not infrequently found to be discoloured, and to possess a faint caramelized odour (15). The tomato sauce in canned herring too, is often found to be discoloured, while the flesh has a rather bitter or cooked flavour (16). It is probable that both of these changes result from reactions of the Maillard type during processing and it may well be that amino-aldehyde reactions contribute to the improvements or deteriorations in quality sometimes observed in canned fish products which have been stored for considerable periods (15).

TARR (15) found that the browning which occurs when the white flesh of fish is heated at 120°C. for 1 hour can be largely overcome if the flesh is extracted with water prior to processing. The active substances removed by the leaching process were not definitely identified, but the flesh was shown to contain or produce on heating small quantities or reducing sugars.

TABLE II

Effect of amino acids and reducing sugars on the browning of leached lingcod flesh during processing for 1 hour at 120°C. (15).

	Colour units (+)
Untreated flesh	8.0
Leached flesh	0.7
<u>Compound added to leached flesh (0.01 M)</u>	
6 amino acids	0.6 - 0.9
Sucrose	0.8
Lactose	4.2
Mannose	6.1
Fructose	3.5
Glucose	4.5
Galactose	6.5
Glucose-6-phosphate	5.9
Arabinose	8.9
Xylose	9.3
Glyceraldehyde	6.0

(+) Lovibond Red + Yellow + Blue units

Addition of reducing sugars or of organic compounds containing a free aldehyde or potential aldehyde group caused browning of the leached flesh, but amino acids or sucrose were without effect (Table II). The discoloration was not an oxidative process since it developed as readily *in vacuo* as in air. Neither phosphate nor traces of iron or copper had any accelerating effect on browning in this system, but sodium bisulphite (1 %) or hydroxylamine (0.5 %) prevented it. The quantities of sulphite required for protection were higher than those usually effective in protecting foods from browning during storage, possibly owing to inactivation of much of the sulphite during heating. Increasing the pH of the flesh above 7 markedly accelerated browning, while decreasing the pH retarded it somewhat.

Another case of browning during sterilization which has been reported is that of canned crawfish (17). Variations in the colour of canned crawfish have been found, ranging from snow-white to brown. Fish caught in one locality may brown, while those caught in another may not. The degree of browning was found to be related to the amount of reducing substances present in the flesh and to the severity of retorting. Storage of the canned products at temperatures between 0 and 21°C. did not appreciably increase discoloration, but storage temperatures in the region of 37°C. caused severe browning. Soaking the fish in running water for about 15 minutes after the first cook minimized browning, but too long a soak resulted in appreciable flavour losses.

4. Vegetables

In the animal products thus far considered we have been concerned with comparatively simple systems in which browning could be attributed in the main to an amino-aldehyde or Maillard type of reaction between reducing sugars (sometimes present only in minor proportion) an protein. In plant products, however, the proportion of protein and its lysine (and therefore free amino) content both tend to be low, whereas a wealth of carbohydrate material including both polysaccharides and reducing sugars and of organic acids (often including ascorbic) is likely to be present. The pH of the fruit or vegetable system too, may be low. It is not surprising therefore to find that chemical data on the nature of the changes occurring during the browning of fruits and vegetables are even more lacking than with animal products, although progress in the practical control of browning has been considerable.

Most of the published work on vegetables has been carried out on dehydrated material, in which deterioration due to browning constitutes a major problem. Similar changes, however, have been reported during the heat processing and storage of canned potatoes (18), and are known to occur during the frying of potatoes. In the latter case the degree of browning which occurs is influenced in very marked degree by the chemical composition, and in particular by the reducing sugar content, of the potato.

Dehydrated vegetables are liable to turn brown during drying, or subsequently on storage, and to develop unpleasant, bitter or caramelized flavours. Such browned material fails to reconstitute properly with water, and aqueous extracts exhibit a marked fluorescence. In some cases a loss of free amino-nitrogen has been demonstrated.

With a number of dehydrated vegetables it has been shown that browning develops in a linear fashion up to and beyond the limit of palatability (19). Dried carrot was found to develop brown pigment eight times as rapidly as sweet potato and yet remained acceptable for nearly the same length of time, which suggests that the natural flavour and colour of the food influences the tolerance for the product of the browning reaction.

The effect of atmospheric oxygen on the rate of browning appears to be small, but the effects of storage temperature and of moisture content are very large. Dehydrated carrot, white potato, onion and sweet potato, for example, were found to brown at rates which varied exponentially with the reciprocal of the absolute temperature, and increased 5 - 8 times for a rise in temperature of 10°C. The rates of browning also varied exponentially with the moisture contents of the four vegetables over the range studied (19).

a. Potatoes

The browning of dehydrated potato has been extensively investigated (20) both in the form of strip and as mashed potato powder (21). The available data indicate that the browning of potato is due in part at least to a Maillard type of reaction between reducing sugars and amino acids. The rate of browning tends to vary with the reducing sugar content of the potato, which can be controlled in large degree by control of variety and maturity and of the temperature at which the potatoes are stored before processing. Browning is roughly doubled by an increase of 3.4°C. in the storage temperature of the dried product, or by an increase of 2 % in its moisture content. Sulphite inhibits the browning reaction both during processing and during

storage, and a combination of low reducing sugar content, sulphiting, and low moisture content gives a product of long storage life. Very low moisture contents have been achieved with dried vegetables by packing with the vegetables a porous container of calcium oxide, thereby continuing the dehydration process in the can.

5. Fruits and fruit products

A review on non-enzymatic browning in fruit products has recently been published (22), and this subject, which is a complex one from a chemical point of view, will only be dealt with briefly here. Fruit products, such as dried apricots or concentrated orange juice, can become very dark on storage, and even quite black if the temperature is high. Commercial concentrated fruit products, like dehydrated vegetables, therefore frequently rely to a considerable extent for retention of their colour, palatability and ascorbic acid content on the protective action of added sulphur dioxide.

a. Orange juice

As already indicated, reactions involving sugars, hydrogen ions and ascorbic and other organic acids, as well as amino acids and amides, probably all contribute to the non-enzymatic browning of fruits and fruit products. In some of these reactions oxygen plays a larger part than in the simple amino-aldehyde or Maillard reaction, sometimes apparently by oxidising ascorbic acid to products which promote browning. Bottled, concentrated orange juice, for example, stored at high temperature will blacken first near the surface in contact with the air, and general darkening in orange juice has been found to increase with increasing headspace in the container.

Table III indicates the kind or results which have been obtained with concentrated orange juice and with model systems built up from known constituents of the juice, evolution of carbon dioxide being used as a measure of the browning reaction. The experiments were carried out at 49°C., at which temperature deterioration is about 20 times as rapid as at 27°C.

TABLE III

Evolution of gas from 25 g. samples of concentrated orange juice and of synthetic mixtures during storage at 49°C (23)

	% soluble solids	% ascorbic acid	ml.gas evolved in 1 month	2 months
Concentrated orange juice				
	30	0.067	0.00	0.00
	41	0.094	0.04	0.28
	49	0.111	0.15	0.63
	60	0.137	0.73	1.45
	64	0.206	0.99	2.91
	71	0.161	3.08	9.25
Synthetic mixtures (+)				
Glucose, fructose or sucrose			0.00	0.00
" + 0.2 % ascorbic acid			0.00	0.01
" + 2.0 % ascorbic acid			6.34	20.94
" + 0.2 % ascorbic acid + 0.4 % $CuSO_4.5H_2O$ ...			0.88	1.03
" + 3 % alanine			0.00	0.28
" + 3 % asparagine			0.02	2.62
" + 0.2 % ascorbic + 3 % alanine .			0.50	1.13
" + 0.2 % ascorbic + 3 % asparagine ...			0.68	2.71

(+) All synthetic mixtures contained 50 % of a sugar, 5 % citric acid hydrate and 3.5 % potassium citrate hydrate pH = 3.7

It was found that orange juice only evolved appreciable quantities of carbon dioxide within the period of the experiment when it had been concentrated to 40% soluble solids, or above. Of the synthetic mixtures, sugars alone produced no gas, but sugars with ascorbic acid or amino acids evolved some gas, while mixtures containing sugars plus ascorbic acid plus amino acids yielded gas in quantity about the same as in concentrated orange juice. Copper, iron or tin salts caused some acceleration of the reaction. Darkening was most pronounced when a sugar and a nitrogen-containing compound were both present. Losses of ascorbic acid and darkening were both found to be greater in lacquered than in plain tinplate cans.

b. Apricots

Experiments on the storage of dried apricots and of extracts prepared from them have shown that at least four general types of reactions are involved in the browning of this fruit, which has a pH of about 3.6 (24). They are :

1) Maillard-type reactions involving nitrogenous compounds and sugars;
2) reactions involving nitrogenous compounds and organic acids;
3) reactions involving organic acids and sugars; and
4) reactions involving only organic acids.

Continuous extraction of apricot concentrates with ethyl acetate during storage at 57°C was found completely to prevent browning of this material, whereas darkening occurred rapidly as soon as extraction was discontinued. The ethyl acetate extract was found to contain furfuraldehydes and other unidentified carbonylic substances. It has therefore been suggested that furfurals are probably important intermediate compounds in the browning of acid fruit systems. Furfurals, at least, however appear to play no important part in the browning of foods or of simple amino acid-sugar systems at more nearly neutral pH, although other reactive carbonylic decomposition products of sugars may.

Sulphur dioxide is very effective in retarding the darkening of dried fruit, but it is gradually destroyed in the fruit during storage. The increase in storage life obtained is roughly proportional to the concentration of sulphur dioxide added. There is, however, no level of sulphur dioxide content above which the fruit will not darken, and it has been shown that apricots may become inedible when about two thirds of the sulphur dioxide originally present has disappeared, although the concentration remaining may still be high enough greatly to prolong the storage life of fresh apricots (25). The mechanism of the protective action of sulphur dioxide is still not fully understood.

c. Tomatoes

Dried tomato develops a typical browning reaction on storage, probably as the result of an amino-aldehyde reaction, which may well be supplemented by other recations of the type outlined above under the influence of the high acidity of the dried product (26). Symptoms of deterioration include loss of palatability and ease of rehydration with water, destruction of ascorbic acid, darkening in colour and production of carbon dioxide and water (27).

Storage experiments with drum-dried tomato flake, gas-packed in nitrogen to control oxidative changes, showed that the product kept satisfactorily at 5°C if the moisture content did not exceed 3.5 %, but for successful storage at room temperature (18 - 27°C) a moisture content of 1.5 - 2.5 % (preferably the former) was necessary, while at 38°C the "shelf life" of the product was short unless the moisture content was reduced to 1 % or below (27). Traces of metal, particularly of copper from the processing equipment accelerated deterioration, while sulphur dioxide controlled it (26).

6. Miscellaneous products

Products additional to those already mentioned in which deteriorative browning reactions have been recognized include baked beans, soups, cereals, meats and coconut. Desiccated coconut, for example, can become yellow on storage, apparently as the result of an amino - aldehyde reaction (28). Reduction of the moisture content to 2 % (the lowest commercially practicable limit) or lowering the pH retards, but does not stop the reaction. The protein and reducing sugar content of the coconut both decrease with ripening of the nut, as does the tendency of the desiccated product to yellow on storage. Partial removal of either amino-nitrogen or reducing sugar by leaching or fermentation retards the browning reaction, but impairs the flavour of the product. Sulphur dioxide, at 300 parts per million or less, effectively protected desiccated coconut for normal periods of storage.

High carbohydrate foods such as dried soups flavoured by the addition of monosodium glutamate or of protein hydrolysates may develop off flavours during storage, particularly when reducing sugars are present or are produced by decomposition of polysaccharides during normal heat processing (29). In some such cases it may be possible to isolate one of the reactants from the other components in a dry system by coating its particles with a barrier material such as hydrogenated fat (30) which is dispersed on reconstitution and heating or cooking after storage.

Maillard-type reactions are probably responsible for the pleasant characteristic odour, flavour and colour of normally roasted peanuts and peanut butter, as well as for the bitter, caramelized flavour of the overheated product. Even in such high carbohydrate foods as syrups, honey and molasses the small quantities of nitrogenous substances present are liable to cause storage problems, particularly at high temperatures.

VII. THE EFFECT OF REACTION WITH SUGAR ON THE NUTRITIVE VALUE OU PROTEINS

While the general question of the nutritive value of canned foods is being discussed elsewhere at this Congress, the specialised case of the effects on nutritive value which could result from reactions of the Maillard-type during processing and storage can conveniently be considered here.

Proteins and amino acids, on the whole, are surprisingly stable and stand up to comparatively severe heat processing and storage without marked loss of biological value, although increased resistance to enzymes and other changes will ultimately occur if protein is heated sufficiently strongly, particularly in the moist state. Evidence, however, has recently been accumulating that severe loss of nutritive value can result under comparatively mild conditions of processing or storage when reducing sugar or other carbohydrate which gives rise to it is also present. In this connexion it should be pointed out that many so-called pure proteins, as ordinarily prepared, contain a small proportion of carbohydrate which might markedly affect their susceptibility to loss of nutritive value on heating. Thus ordinary lactalbumin after autoclaving was found to be unable to maintain dogs in nitrogen equilibrium, where as the same material after exhaustive extraction until it failed to give a Molisch test for carbohydrate withstood the same heat treatment without apparent loss of nutritive value (31).

Bacteriological media sterilized in the presence of glucose have proved to be deficient in essential amino acids and in amino vitamins of the B group, and protein hydrolysates used for intravenous alimentation have been found to deteriorate in nutritive value when similarly treated. Proteins too, such as casein and soya bean globulin, have shown very marked losses of lysine, arginine, histidine, tryptophan and methionine after refluxing or autoclaving with reducing sugars (32, 33).

Even at much lower temperatures a comparatively rapid decrease in nutritive value can occur if protein is stored with reducing sugars under conditions, particularly of moisture content, which are favourable for an amino-sugar reaction. In a storage experiment with a casein-glucose mixture approximately two thirds of the lysine present was found to have reacted with sugar within 5 days at 37°C. (34). After 30 days over 90 % of the lysine has disappeared, together with 70 % of the arginine, 30 % of the histidine and considerable quantities of tyrosine and methionine. All the tyrosine and methionine, and two thirds of the

lysine could be recovered by hydrolysis with acid or alkali but none of the arginine or histidine. The resulting loss of nutritive value of the protein is shown in fig. 3.

Losses of amino acids resulting from a protein - sugar reaction, whether it occurs rapidly during heat processing or slowly during storage, therefore seem to be of at least two types, namely :

a) destruction of the amino acid in the sense that it cannot be regenerated even by complete hydrolysis of the protein with acid or alkali; and

b) inactivation of the amino acid as a result of binding in a complex from which it cannot be released by enzymic hydrolysis (or is only split off too slowly to be able to supplement the other amino acids in digestion), but from which it can be regenerated by hydrolysis with acid.

Binding of type b) may in some cases develop subsequently into type a). Artificially prepared protein-sugar complexes have been tested for digestibility by enzymes <u>in vitro</u> and found to be particularly resistant to tryptic action, although they were attacked, somewhat slowly, by pepsin, chymotrypsin and pancreatin. It is obvious from all these data that microbiological assay after acid hydrolysis, as has been used very widely, can give at best only a very incomplete picture of losses in nutritive value which result from the protein-sugar reaction, and that bioassay with mammals is essential if the results are to be of any value (35).

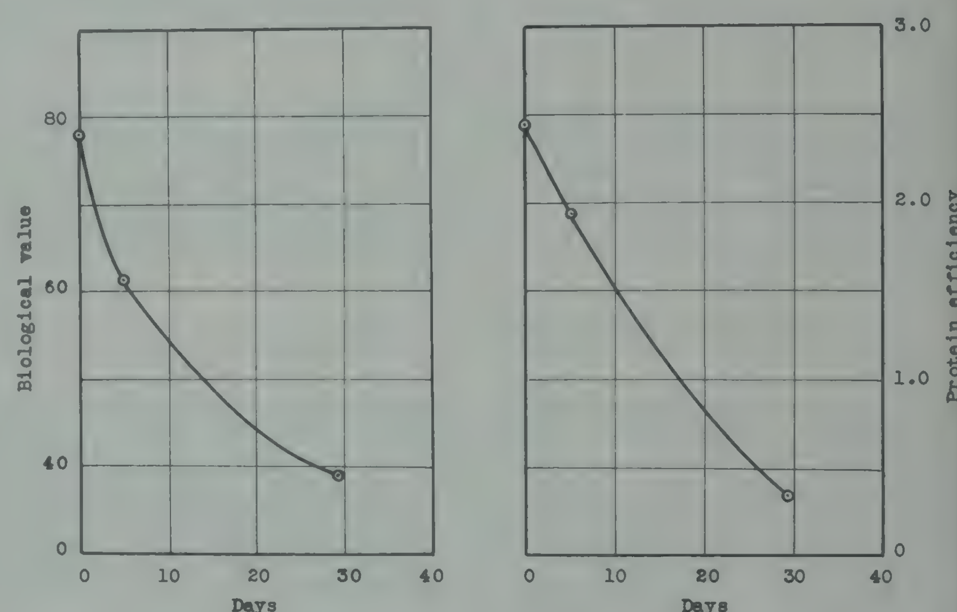

Fig. 3. Changes in nutritive value of casein stored with glucose (4 equivalents) under nitrogen at pH 6.3, 70 % R.H. and 37°C.

The foregoing brief review of the changes which have been shown to occur in model protein-sugar systems under favourable conditions should not be taken as implying that losses in nutritive value of this order of magnitude are occurring daily in the ordinary processing and storage of our basic foods. In fact, the methods currently used for processing such important protein foods as milk, meat and fish appear to result in very little loss of biological value. In canned meats, for example, the nitrite commonly added is probably a considerably greater destroyer of lysine than is the protein - sugar reaction, and even in dried foods such as milk powder the loss of biological value of the protein can be reduced to negligible proportions during long periods of storage by controlling the moisture content at a sufficiently low level (2). With some of the cereal breakfast foods, however, a very marked loss of nutritive value of the protein undoubtedly occurs during the severe heat treatment to which they are subjected in processing (36). The food technologist therefore needs to be on the look out for a possible loss of nutritive value among the varied consequences of the non-enzymic browning reaction.

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XXXVIII. DEVELOPMENTS IN TIN PLATE TECHNOLOGY

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I. INTRODUCTION

The aim of this paper is to convey a broad view of the technical development on the tinplate industry throughout the world since the meeting of the First International Congress on Canned Foods in 1937. Manufacturing processes and the applications on tinplate in food canning in relation to the properties of the material are the chief items considered; food cans and similar containers, although consuming a major proportion of tinplate production, are not discussed as they form the subject of another contribution by Mr. Jakobsen.

The period under review is especially one in which, partly stimulated by years of war, enormous technical progress has been made in a great number of industries : but the tinplate industry can claim more than technical progress; it has undergone revolution. More than half the world's tinplate is now made by a process which in 1937 was only in the experimental stage. This revolution, the manufacture of tinplate by electrodeposition instead of by dipping in molten tin, has occurred entirely during the period reviewed. Another major revolution, although starting a decade earlier, has come to full fruition during the same period, it is the production of the steel base in great lengths by continuous cold reduction instead of in single sheets by hot rolling, doubling and shearing. For although in 1937 the percentage of tinplate made from cold-reduced strip was already about 20 %, it has now risen to about 65 %.

As a matter of course there have been numerous minor improvements in tinplate manufacture, but in comparison with the two fundamental changes noted above they have little significance. There are good grounds, therefore, for restricting the part of this paper devoted to manufacture to a discussion of the two revolutionary changes and their impact on the canning industry. Both changes are linked with large scale production and originated in the United States of America. The only change of equal importance in the past history of tinplate manufacture was the introduction of steel for tinplate base instead of the wrought iron formerly used. This occurred in Great Britain between the years 1875 and 1880.

Another cardinal feature of the world's tinplate situation which deserves to be mentioned at this stage is the progressive diminution in the average thickness of the tin coating on tinplate which has occurred during the period under review. For in 1937 the world production of tinplate was about 4,200,000 tons for a consumption of 69,000 tons of tin, whereas in 1950 the corresponding figures were 5,750,000 tons and 61,500 tons. The technical significance of this is discussed later, but here it may be said that the thinner tin coatings were only made possible by the introduction of the two processes which have been described as revolutionary.

II. THE CONTINUOUS COLD REDUCTION PROCESS

In order to appreciate the newer process of manufacture of the steel base for tinplate it is necessary to recall the traditional hot pack-rolling process which determined the pattern of the subsequent tinning and finishing operations and which is still used in many parts of the world. The process starts by rolling down a comparatively small ingot (say 25 cwt.) to a tinplate bar (about 15 Ft. x 10 in x 0.5 in.) which is then cut into shorter lenghts to suit the width of finished sheet required. The short bar is first hot-rolled as a single piece and the "single" then doubled (folded over on itself), reheated and rolled double. The sequence of rolling, doubling and reheating is repeated until a pack of eight sheets of correct gauge is produced. Individual sheets are obtained from the pack by shearing to size and tearing apart the sheets, an operation known as "shearing and opening". They are then "black pickled" in hot dilute sulphuric acid to remove the scale acquired during rolling. Although the pack of sheets is rolled hot, the temperature is not sufficiently high to avoid work-hardening and the work-hardening has to be overcome by "black annealing" at 800-850°C. At this stage the sheets have a matt surface which would not yield a brilliant finished tinplate

and in fact would take up an excessive amount of tin. For these reasons the sheets are cold rolled by passing individually through a succession of 2-high stands. The purpose is to achieve an improved surface and an insignificant degree of reduction (about 1 %) is aimed at; nevertheless a certain amount of work-hardening occurs and is later removed by "white annealing" at about 650°C. The superficial oxide skin which is produced on the surface of the sheets in this operation is removed by "white pickling" in dilute sulphuric acid. The sheets are then ready for hot-tinning.

Essentially, pack-rolling is designed to make individual plates and it is important that they do not stick together in the pack. This property is affected very strongly by the phosphorus content of the steel, which for pack-rolling may be as high as 0.08 % and cannot conveniently be less than 0.04 %. This phosphorus content sets a limit to the usefulness of the material.

On the other hand, continuous cold reduction is designed to make steel base in the form of long strip and the fact that it may afterwards be cut into individual sheets of tinplate size is incidental. If the strip is to be made into electrotinplate it is kept in a coil and electro-tinned as a continuous strip, being cut into plates only afterwards for the convenience of the can-maker. Moreover, can makers are becoming increasingly interested in the possibility of making cans directly from the coil of strip. If the strip is to be made into hot-dipped tinplate it is cut into plates because the hot-tinning machinery is designed to deal with plates.

The essence of continuous cold reduction is that a large mass of steel is brought down to finished gauge all in one piece, giving in the first place much greater uniformity in gauge and temper. But the effects are far-reaching, for major reduction of thickness is effected by cold rolling instead of hot rolling, so that the structure and mechanical properties of the sheet are different. Moreover, the continuous process enables a more favourable composition of steel from the corrosion viewpoint to be used; in particular the phosphorus content can be reduced and is usually between 0.005 and 0.02 % unless a specially stiff plate is required for particular purposes.

The starting material for cold-reduction is a slab weighing several tons which has been hot-rolled from a large ingot. Before cold-reduction can begin the slab is reduced to strip about 0.07 in. thick by hot-rolling. The slab is reheated in a furnace and passed successively through four or six stands (the hot-roughing group) in which scale is broken up and progressive reduction effected; the strip then passes through a train of five or more hot-finishing stands, undergoing further reduction, and is then coiled. The oxide scale left after these operations is removed before the cold-reduction stage begins. For this purpose the coiled strip is sent to the continuous pickling plant, where it is uncoiled and passed continuously through hot dilute sulphuric acid, real continuity being assured by stitching or welding the end of one coil to the beginning of the next.

Then comes cold-reduction proper, which is effected by passing the pickled and oiled strip continuously through a succession of from four to six cold-rolling mills, finishing at a thickness of about 0.01 in. There is no intermediate annealing and rolling speeds are high, the speed of delivery from the last stand being in some plants as high as 5000 ft. per min. Each successive stand is run at a higher speed than the preceding one so that it not only takes up the gradually lengthening strip, but also keeps the strip under tension during cold-reduction. During the process there is considerable work-hardening, which must be removed by annealing; but before annealing it is important to remove the cold-rolling lubricant from the surface of the steel, as otherwise residues are left which make the steel difficult to tin. Degreasing methods vary in detail, but as a rule the gross oil is removed by jets of warm alkaline solution, leaving the rest to be removed by electrolytic treatment in, say, sodium orthosilicate solutions. The strip is usually annealed as a coil at a temperature near 700°C. This treatment leaves the strip in a dead-soft condition which is unsuitable for the fabricating operations involved in the manufacture of cans. The strip is therefore "temper-rolled", in which operation it receives a small amount of cold-reduction sufficient to impart the required degree of stiffness or temper.

Apart from increased production rate the cold-reduction process yields material that is much more uniform as regards thickness, flatness, temper and other mechanical properties, and these characteristics are kept under control. Moreover, the process lends itself to the use of steel having a higher intrinsic corrosion resistance which, coupled with the remarkably high surface finish, has enabled the effective quality of hot-dipped tinplate to be maintained in the face of a reduced tin coating thickness. With the trend towards thinner coatings the quality of the steel base becomes more important.

III. ELECTRO-TIN PLATE

Electrotinplate is an entirely new product developed since the First International Congress on Canned Foods, but already it approaches 50 % of the world output. The advent of continuous cold-reduction shifted the viewpoint of the industry from the single sheet to the long coiled strip. It was natural that attention should be given to carrying the idea of continuity right through the subsequent stages of tinning with the aim of continuous production of tinplate in strip form at high speed. In the few years immediately preceding the 1939 war, investigations were in hand in several countries on the continuous electrolytic and hot-dip tinning of steel strip and promising results had been obtained by both methods. Intensive research work during the early 1930's on the electrodeposition of tin had provided a better understanding of that process than was available for hot-tinning, and whereas continuous hot-tinning only gained acceptance on strip a few inches wide, the electrolytic method was developed into a process capable of dealing with all tinplate widths. Already in 1937 two pilot lines, one working with 32 in. wide strip and the other with 20 in. strip, were in action in the United States.

The really intensive development of electrotinplate manufacture came in the United States in 1941 and 1942 following the occupation of important tin-producing countries by the Japanese. This emphasised an added attraction of the electrolytic method - that the tin coating thickness could be controlled fairly accurately at any thickness that could normally be desired. By electrodeposition it is possible to make both thicker and thinner coatings than can be made by hot-tinning. Naturally interest was focused on the thinner tin coatings rendered available by the new method and tremendous stimulus was given to solving the various mechanical and electrical engineering problems involved in large scale production. Within five years there

were 25 full-scale electrolytic lines working in the United States; several have been added in recent years and the process has been taken up by tinplate manufacturers in other countries. In Great Britain one electrolytic line commenced operation in 1947 and two other lines are about to come into production. Two lines are working in Canada and one in Belgium; and the process has been under consideration in France and Holland.

An electrolytic tinplate line comprises a series of processing units all connected in tandem and running synchronously together. Coils of cold-reduced strip 30 in. wide or more and weighing several tons are uncoiled and passed successively through degreasing and pickling tanks and the electro-tinning bath with intermediate water washes; then the plated strip passes through a radiant or high frequency furnace or is heated by electrical resistance in order to melt the tin coating for a fraction of a second to brighten the plate; it is then generally lightly oxidised to improve lacquering quality by passing through a chromic acid or other chromate bath and finally oiled lightly by a mist of oil droplets. Afterwards it is cut up into sheets of ordinary tinplate size.

All the processing of the strip is usually carried through strictly continuously by welding or stitching the end of one coil to the beginning of the next without stopping the line. This is done by arranging a looping pit or strip accumulator in the chain of operations, so that while a join is being made the line can be kept going. The speed of operation is high, varying from 600 to 2000 linear feet per minute according to the type of installation. A high rate of production is essential to offset the heavy capital cost of the plant. The speed of shearing is not equal to the higher speeds of cleaning, pickling, plating and finishing, so although electrotinplate is sheared in line in the lower speed range it is coiled and sheared in a separate operation in the high-speed installations.

Four different electrolytes are in use in electrotinplate lines. The oldest is the stannous phenolsulphonate solution and this bath has not diminished in popularity. It is a solution of stannous tin in phenolsulphonic acid with excess of sulphuric acid and an organic addition agent. The bath can be worked cold, but is improved by allowing the temperature to rise above normal, which it readily does owing to the heating effect of the electric current. The two newest lines coming into operation in Great Britain this year will work at 800 linear feet per minute. The fastest electrolyte is the so-called " halogen bath " which is a slightly acid solution of stannous chloride containing alkali-metal fluorides and an organic addition agent. It is used warm (about 65°C) and the very high current densities which are permissible enable the strip to be run through at particularly high speeds (up to 2,000 ft. per min.). The sodium stannate bath has also been used since the earliest days of electrotinplate manufacture. The electrolyte contains sodium stannate with excess of sodium hydroxide, and smooth coatings are obtained without the need for any addition agent. The bath is used hot (80-90°C), and generally lower current densities and lower linear speeds of strip prevail. A few lines use a corresponding potassium bath (i.e. containing potassium stannate and excess of potassium hydroxide). This bath is also used hot and without addition agent. Potassium stannate is more soluble in water than is sodium stannate, especially at higher temperatures so that better plating efficiency is obtained at high current densities. To enable the rate of tin anode dissolution to keep pace with the increased cathode current density recourse is had to a special anode of tin alloyed with a small quantity of aluminium.

In every case the current density is greatly in excess of those usual in still plating; the current density may be in the range 200-500 amp. per sq. ft. while the actual plating time is reduced to a few seconds. High current densities are made possible by the high rate of relative motion between cathode and electrolyte.

The preceding paragraphs give only the barest outline of the principles of electrotinplate manufacture. The installations are marvels of electrical engineering and prodigious effort has been expended in developing so large a new industry in a short period of time. Nevertheless, chemical aspects of processing still leave much room for further study and invention. The quality of the product is not determined solely by the electrodeposition process, although that in itself merits constant study both as regards cathodic and anodic reactions. The preparation of the steel before plating is of at least equal importance in determining the covering power of the tin coating. Annealing, cleaning, and pickling procedures all play their part in determining the actual distribution of the tin in the plating stage which follows. These problems, however, are still the subject of research. Their importance is that the characteristics of the tin coating determines to a large extent the degree of corrosion resistance of the tinplate, and corrosion resistance is the first property required of tinplate. The chemical composition and surface finish of the steel are other factors strongly affecting corrosion resistance of tinplate.

At this stage it is well to point out that electrotinplate is not by necessity thinly tinned steel sheet, although it is fair to say that at the present time thinly coated tinplate is of necessity electrolytic. The electrolytic method is inherently capable of yielding any coating thickness likely to be desired, but it is the only process capable of giving really thin coatings and has in fact mainly been used for the production of thin coatings; hence it has been popularly associated with thin tin coatings. Naturally every effort has been made to reap the advantage of lower tin consumption and the usual tin coating thickness of electrotinplate is only 0.00003 in. This material is generally used lacquered and is by no means acceptable for all food packs. A certain amount of electrotinplate carrying as much as 0.00005 in. of tin is made for canning milk. Quantities of electrotinplate having a coating thickness of 0.00006 in. (equivalent to the thinnest hot-dipped tinplate) have been made and are undergoing service trials, but this material is not yet available commercially. In the other direction there is a considerable output in the United States of electrotinplate bearing only 0.000015 in. of tin, which is used mainly for beer cans, oils, greases, etc.., and for food for dogs and cats.

In the food canning industry the thickness of tin coating required in the container is a most interesting point. Economic considerations have urged a steady reduction in the thickness since the early days of canning. This reduction has in fact been practicable because of technical advances, particularly in the technique of steel sheet manufacture. As the surface and chemical resistance of mild steel sheet have been improved, so it has been possible to maintain the quality of tinplate while using less and less tin. In other words there has hitherto always been enough tin and the problem has been its even distribution; improvement in the steel base has made it possible to apply thinner tin coatings without increasing the porosity. For this reason in some circles porosity has come to be regarded as the limiting factor regulating the thickness of tin coatings.

As an out come of electrotinplate manufacture the author believes that the time has now come when

the view expressed above is no longer tenable. The first function of the tin is to act as a chemical barrier between the steel container and the contents. This is in reality a delaying action on the part of tin and in the long run it is a losing battle. Small amounts of tin compounds are always found in canned foods, increasing with time of storage, and 100 parts per million is a common tin content to find in unlacquered can packs. (As much as 286 p.p.m. is tolerated in the U.K. and 300 p.p.m. in the U.S.A.). But if the contents of an A 2 1/2 can contain 100 p.p.m. of tin it can be calculated that the tin coating thickness has been reduced by 0.000009 in. It is therefore clear that an initial tin coating thickness of 0.000015 in would be quite unsatisfactory for such packs even if it were originally pore-free.

IV. RESEARCH AND THE FUTURE

As in other industries research on tinplate has intensified in recent years, and numerous laboratories in Europe and America are working on various aspects which interest them as manufacturers or users. Much of this effort is devoted to the steel base material to give the can makers what they require in deep-drawing and other forming qualities. The steel base and the tin coating determine jointly the corrosion resistance of the tinplate, both in relation to the can contents and the outside atmosphere; they determine the losses through blown cans or rusty cans.

The corrosion aspect is extremely complex and has a considerable scientific literature of its own. It cannot be divorced from manufacturing interests, because processing technique can have a great influence on the corrosion - resisting quality particularly of the more thinly coated tinplates. It is also highly dependent on methods of testing, which at present are far from being universally acceptable. In spite of all experimentation devoted to determining the porosity of tin coatings, or determining the rate of evolution of hydrogen when tinplate is treated with acid, or determining the amount of iron or tin dissolved from tinplate under certain conditions, none of these methods has gained acceptance by canners as a real measure of the quality of the tinplate they are using. In fact the canner's test remains a packing trial. Philosophically it is probably idle to suppose that the idea of a general level of quality has any meaning except in regard to the particular use to which the tinplate is to be put. Nevertheless a simple and rapid test that gives a fair correspondence with general experience of shelf life would be welcomed by all sides of the tinplate and canning industries.

The improvement of the corrosion resistance of tinplate by treatments after manufacture has also exercised the minds of chemists. In the "Protectatin" process, which delays the onset of rusting of the can exterior and prevents sulphide blackening of the interior, this is achieved by a simple dip in a hot alkaline chromate solution. Although at present this is only used on a small scale for hot-dipped tinplate, it is used in modified form as a matter of course in the final stage of electrotinplate manufacture.

Some further improvement in quality of tinplate may be looked for as the problems of perfecting the even distribution of tin whether by hot-dipping or by electrodeposition are solved. But, as explained above, chemical reactivity sets a limit to the performance of a tin coating of given thickness. It may therefore be expected that attention will continue to be given to the economical production of electrotinplate having a greater range of tin coating thickness than is available now. Indeed, if electrotinplate is to realise its full stature it is vital that the industry should be able to produce economically a material carrying at least 0.00006 in. of tin. This does not necessarily mean a general up grading of electrotinplate, but the provision of thicker electrolytic coatings for the many uses where chemical considerations demand them.

Perhaps, too, the next few years may witness development in the production of tinplate by continuous hot-tinning of cold-reduced strip. In that case at a future meeting of the International Congress on Canned Foods we should be able to announce yet a third revolution in the tinplate industry.

XXXIX. DEVELOPMENTS IN TIN PLATE AND TIN PLATE CONTAINER MANUFACTURE IN THE UNITED STATES DURING THE LAST 12 YEARS

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The last 12 years have seen many changes in the types of materials used in the construction of metal containers, most of them engendered by wartime restrictions on the use of tin supplemented by the development of the electrolytic tinning process and improvements employed in rolling and annealing the steel used in the manufacture of tin plate.

Of all the multitude of wartime restrictions on the use of the various metals, the controls on tin were the very last to be removed (Order M 81 expired December 1, 1949). The canning and can manufacturing industries were, in fact, just adjusting to the idea of unlimited use of tin when hostilities broke out in Korea, making curtailment of the use of tin again essential.

As tin controls were slowly relaxed, particularly after World War II, there was a slight trend back to the use of prewar materials. But to a large extent, the wartime materials were more economical and were frequently giving better service than was obtained before the war. In looking forward, therefore, to the possibilities of further controls, the industry appears to have the attitude that it has employed alternate materials successfully for a number of years, and can develop further alternates if necessary.

I. TIN PLATE

The continuous cold reduction of steel to light gauges, introduced in the early thirties, caused a technological revolution in the manufacture of tin plate and resulted in a greatly improved product. Although the hot rolling mills became obsolete in that same decade, and the last of them were scrapped in 1948, the implications of changing the manufacture of tin plate from a batch to a continuous process are still being felt and will be felt for some years to come.

The continuous strip method of rolling steel, shown in figure 1 (p. 2), was still so new in 1939 that it was to be expected that numerous modifications and improvements in the manufacture of tin plate would be made in the following 12 years. Many changes have been made, increasing the rates of production and introducing additional continuous procedures. The changes in tin plate manufacture which are of greatest interest to the canner concern the coating weights of tin on the plate. Before discussing tin coatings in detail brief mention will be made of changes in the chemical and physical specifications for the base steel.

1. Corrosion resistance of base steels

The first commercial attempt to control the corrosion resistance of tin plate through regulation of the composition of the base steel was made in 1932 (1). The initial chemical specifications issued by the American Can Company were based on the results of many experimental packs. These were made to determine both

NOTE : Figures between ( ) refer to Bibliography, p. XXXIX - 13.

the corrosivity of representative food products and the effect of varying the amounts of each of the elements in the base steel on the shelf life of cans made from the corresponding lots of tin plate.

Current specifications for base steels, adapted slightly, are given in table I. They take cognizance of three types of steel required for three different classes of food products, and a fourth type used only for beer can ends. Type L (low metalloid) plate is specified for the most strongly corrosive products, known as Class I items, such as sauerkraut, berries, cherries, dried prunes in syrup, and pickles. MR steel is specified for Class II products, with intermediate corrosivity, such as peaches, pears, pineapple, and citrus products. MC plate is specified for the least reactive items, Class III products, such as peas, corn, meats, and fish (2).

HARTWELL (3) has discussed in detail the effect of various amounts of P, Si, S, C, Mn, Cu, Ni, and Cr in the base steel upon the corrosion resistance of tin plate. Results are also available, as yet unpublished, on the effect of Mo and As.

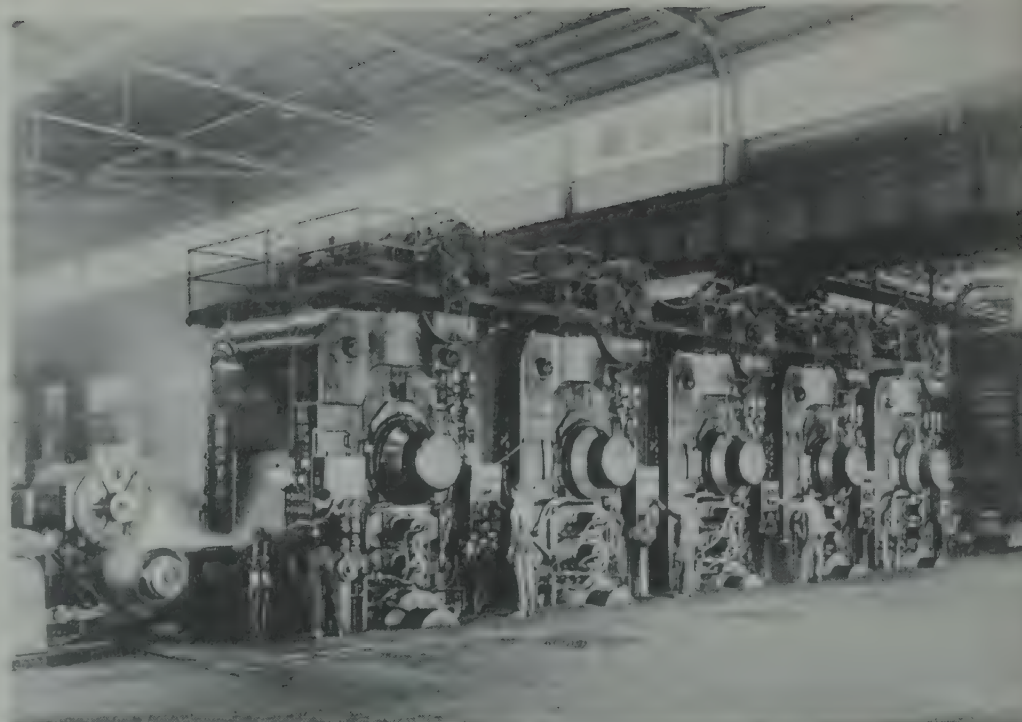

Fig. 1. Cold reduction mill. Producing thin steel strip. United States Steel Corporation.

TABLE I. CHEMICAL SPECIFICATIONS FOR BASE STEELS

Element	Type L	Type MR	Type MC	Special for beer ends only
	(T-1, 2, 3, 4)	(T-1, 2, 3, 4)	(T - 5)	(T - 6)
	Percentage permitted			
Carbon	.05 - .12	.05 - .12	.05 - .12	.05 - .15
Manganese	.25 - .60	.25 - .60	.25 - .60	.25 - .70
Sulphur	.05 Max.	.05 Max.	.05 Max.	.05 Max.
Phosphorus	.015 Max.	.020 Max.	.07 - .11	.10 - .15
Silicon	.010 Max.	.010 Max.	.010 Max.	Residual
Copper	.06 Max.	.20 Max.	.20 Max.	Residual
Nickel	.04 Max.	No limitation specified		
Chromium	.06 Max.	" " "		
Molybdenum	.05 Max.	" " "		
Arsenic	.02 Max.	" " "		

Examination of the specification for type L plate will indicate the critical control of "tramp" or residual elements, such as copper and nickel, in the base steel which is necessary to obatin maximum corrosion resistance. About 50 per cent of the metal charged into an open hearth furnace is scrap steel which may bear residual metals as alloy or plating, and the scrap may be used over and over again. Over a period of years, there has been a gradual but steady accumulation of residual metals in steel scrap in the United States. As a result it has become more and more difficult for the mills to produce heats which meet type L specifications. It is fortunate, therefore, that less than ten per cent of the steel for tin plate must be of type L composition. To compensate for the extra cost of selecting scrap with low tramp metal content, or otherwise producing heats low in residual metal, the steel mills within the last year have charged a small differential for type L plate.

2. Physical properties of base steels

Since 1939 there has been no change in the temper classification of tin plates but supplemental information on anticipated tensile properties has been added. The temper classification was devised in the

iddle thirties to convert can making requirements, such as panelling and buckling resistance, into physical roperties which can readily be measured in the steel mill, for example, hardness, ductility, and bendability 4). Panelling resistance is defined as resistance to that external pressure which tends to produce distortion of can bodies packed under high vacuum, resulting in flat or collapsed areas on the bodies. Buckling esistance is resistance to internal pressure, developed during thermal processing or because of carbonation, hich tends to cause ends to buckle at the countersinks and extend above the double seams.

The six tempers range from the softest tin plate practical for the mill to produce, T1, to the stiffest late practical for the can manufacturer to fabricate, T6. Current specifications for physical properties f tin plates are shown in table II.

TABLE II. SPECIFICATIONS FOR PHYSICAL PROPERTIES OF TIN PLATE.

PLATE	TEMPER	ROCKWELL SUPERFICIAL HARDNESS 30 - T		CUP TEST (.0100"T1.)	APPROXIMATE SCHOPPER VALUE Kg/Sq. MM	ANTICIPATED TENSILE PROPERTIES IN THOUSANDS PSI (+)	
		Aim	Permissible deviation			Yield point	Ultimate tensile strength
L or MR	1	49	± 3	.320	20 - 24	39 - 47	47
L or MR	2	53	± 3	.300	23 - 27	41 - 50	50
MR	2 1/2	55	± 3	.290	24 - 28	42 - 52	52
L or MR	3	57	± 3	.280	26 - 30	45 - 55	55
L or MR	4	61	± 3	.260	29 - 33	49 - 59	59
MC	5	65	± 3	.240	32 - 36	54 - 64	64
Beer end	6	70	± 3	.200	37 - 45	-	-

(+) PSI - Pounds per square inch

Fig. 2. Can parts - Illustrating tempers of tin plate employed in fabrication of metal cans.

Tin plates of T1 and T2 characteristics are used in deeply drawn containers such as oval oil can tops and oval or oblong fish can bodies. Plates of T3 and T4 properties are commonly used in the bodies and ends of processed food cans. T5 plate is applied where higher resistance to buckling is required, such as in the ends for large diameter cans for items like peas, corn, and spinach; or where high resistance to panelling is required, such as in the bodies of cans closed under high vacuum. T6 is employed only in the ends of cans for beer where extreme buckling resistance is required figure 2 shows examples of can parts made from plates of the various tempers.

Application of the temper classification permits the can manufacturer to tailor-make cans to obtain maximum performance from the minimum weight of steel. It has also proved particularly advantageous to can factories because it has eliminated the mill-to-mill and batch-to-batch variations in the physical properties of plate received.

3. Continuous annealing

Continuous annealing is an obvious extension of the continuous cold reduction process. In fact, it is the last in the series of operations in the manufacture of tin plate to be converted from a batch to a continuous process. In the new method the strip is raised to about 1300°F to remove cold reduction strains, then cooled in a deoxidized gas. At the present time the plate is being made to Rockwell 30 T hardness of 65 ± 3, essentially of the same hardness as the MCT5 plate. A photograph of a continuous annealing unit is shown in figure 3, p. 4.

Continuously annealed plate has more uniform physical properties than conventional coil annealed plate. But the big advantage to the can manufacturer is that the plate has excellent ductility as well as necessary tensile strength and hardness. Previously a can manufacturer could buy a soft steel for deep drawing applications or a hard steel where strength was required. Present knowledge indicates that with continuously

annealed plate he may be able to have both in the same lot of plate. Such a situation will go far in reducing the number of types of tin plate purchased, thus simplifying a tin plate inventory problem which has become increasingly serious as tin plate technology has advanced in the last 20 years.

4. Tin coatings

a) Hot dipped plate

As stated previously, the changes in tin coating in recent years are perhaps of most interest to the canner. They concern both hot dipped plate and the new product that has revolutionized tin plate usage - electrolytic tin plate.

Before World War II practically all tin mill product was hot dipped plate. Approximately 1.5 lb. of tin were used in producing a base box of "coke" plate. In 1941 the Office of Production Management reduced the amount that could be employed to 1.35 lb., and later the War Production Board reduced it to 1.25 lb., about the minimum amount that can be used in the hot dipping method. In each case the weight of tin refers to the amount consumed in the tinning process rather than the weight of tin on the plate.

During the war 1.50 lb. plate was retained for the most corrosive products such as cherries, berries, sauerkraut, and prunes. The 1.25 lb. plate was employed for the moderately reactive products such as citrus fruits, tomatoes, evaporated milk, etc...

At the conclusion of the war the nomenclature was changed. The plate formerly called 1.25 lb. is now known as " common cokes ", the 1.50 lb. is now " standard cokes "; and a 1.70 lb. plate is known as " best cokes ". Definitions for the plates have been elaborated by the American Iron and Steel Institute as given in table III (5).

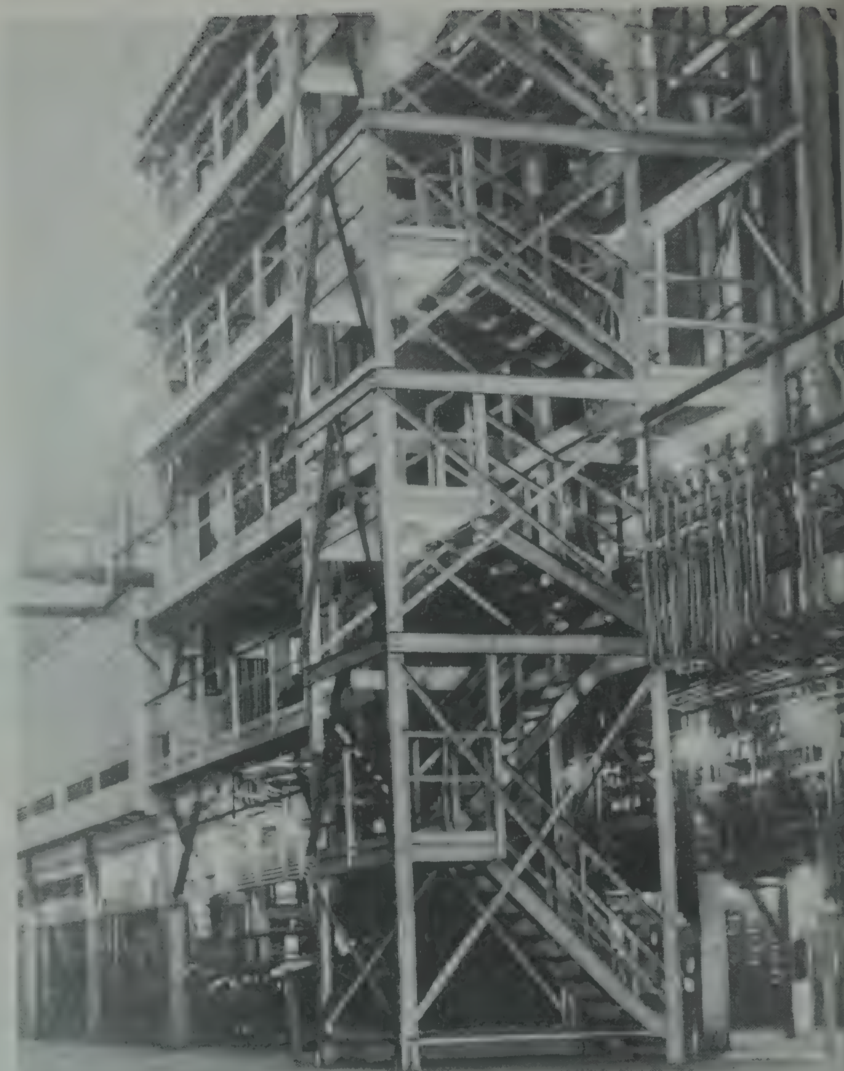

Fig. 3. Continuous annealing furnace. Inland Steel Company.

It should be emphasized that these values are minima. Table IV (p.5) is included to show the statistical relationship to the nominal weights of coating on the plate and the amounts of tin consumed to produce the coatings (pot yields).

TABLE III. TIN COATING WEIGHT TEST VALUE (5, 6)

Class designation	Minimum average coating weight test values (+) Pounds per base box
Common cokes	0.85
Standard cokes	1.05
Best cokes	1.19
"Kanners" special cokes	1.40

(+) The average test value is determined by taking one plate at random from each 50 packages with a minimum of three samples plates per shipment. Three spot samples, each 4 sq. in. area, are taken from each plate along a diagonal and avoiding the extreme edges. The average value of all spot tests on all plates tested is the average coating weight test value.

During late 1949 and the early part of 1950 it was expected that relaxation of tin controls would permit use of heavier coatings of tin on hot dipped plates for the most corrosive products. However, plans for such coatings had to be abandoned in June 1950 when the Korean hostilities made further conservation of tin necessary.

At the present time, usage of plate for cans is controlled by National Production Authority Order M-25 (7). No best cokes are permitted. Standard cokes are again specified for products such as berries, cherries, prunes, etc.... Common cokes are indicated for those products where enameled electrolytic plate is not applicable, for citrus fruits and juices, beets, and for the bodies of cans for tomatoes, carrots, and green leafy vegetables.

Since the hot dipping procedure is a batch process, its ultimate obsolescence was forecast when the mills began to employ the continuous cold reduction method of rolling the steel for tin plate. Today less than half of the tin plate produced in the United States is hot dipped, and improvement of the corrosion resistance of plain electrolytic plate will further weaken its position.

b) Electrolytic tin plate

The electrolytic tinning process permits a close control of tin coating, promotes uniform distribution of tin, and is capable of producing very light but still uniform coating weights. Plate bearing only

TABLE IV. APPROXIMATE RELATION BETWEEN MINIMUM TEST VALUE, COATING WEIGHT AND POT YIELD (6).			
(Coke tin plates)			
Designation	M.T.V. lb./base box	Average coating wt lb./base box	Pot yield lb./base box
Common cokes	0.85	1.10	1.25
Standard cokes	1.05	1.35	1.50
Best cokes	1.19	1.50	1.70
"Canners" special cokes	1.40	1.80	2.00

.25 lb. of tin per base box has been produced and used in large quantities, and even thinner coatings have been proposed. As a further means for conserving tin it has been suggested that tin be electroplated only on that side of the steel strip which is to become the inside of the cans.

When steel for tin plate was first cold reduced on a continuous basis it was to be expected that some day all of the various manufacturing operations would be changed from batch to continuous operations. Plans for continuous tinning took only a few years, and in 1937 the first commercial electrolytic plate was produced. It carried 0.5 lb. of tin per base box and was used for the manufacture of can ends and closures for dry products. The principal requirement was atmospheric rust resistance and, under the conditions of distribution in the domestic market, this weight of tin gave satisfactory performance.

Fortunately, in the late thirties experimental packs were made of a number of food products in both plain and inside enameled cans fabricated from the 0.5 lb. plate. It was found that the plain cans became hydrogen springers in a very short time but that many of those made from enameled plate had a satisfactory shelf life. The results of experimental packs of two relatively non-reactive products in plates made of the same heats of steel are shown in table V.

TABLE V. COMPARISON OF CORROSION RESISTANCE OF ENAMELED AND PLAIN ELECTROLYTIC TIN PLATE (No. 2 Cans)						
			Storage at 100°F		Storage at [illegible]°F.	
Product	Plate	Enameled	Days to First Failure	Days to 50 % Failures	Days to First Failure	Days to 50 % Failures
Peas	1.25	Yes	1350	1410	0 at 2700 days	
"	0.5	Yes	1350	1380	0 at 2700 days	
"	0.5	No	450	600	1020	1590
Chicken Noodle Soup	1.25	No	990	1320	0 at 2580 days	
" " "	0.5	Yes	1440	1500	0 at 2580 days	
" " "	0.5	No	330	510	1050	1560

When war flared in the Pacific in 1941, the results of these experimental packs, plus the results of studies on 1.35 lb. and 1.25 lb. hot dipped plates, and on chemically treated and untreated steel, were utilized to project a four stage program of increasing tin conservation ([illegible]). The success of this program is indicated in table VI. For comparison purpose figures for 1950 are also cited.

TABLE VI. TIN CONSERVATION STATISTICS (9)				
	Tin Mill Products short tons	Tin Applied on Tin Mill Products long tons	Tin Applied on Tin Mill Products Av. lbs./base box	Cumulative Tin Savings long tons
1940	3,269,986	40,189	1.31	
1941	4,551,597	46,650	1.14	6,829
1942	3,333,633	29,404	.94	18,396
1943	2,698,108	22,643	.90	28,814
1944	3,318,621	26,337	.85	43,263
1945	3,653,600	27,400	.80	60,766
1950	5,316,211	37,450 (estimated)	.75	

The "work-horse" of the tin conservation program was enameled electrolytic plate. In 1942, the War Production Board authorized the construction of [illegible] electrolytic tinning lines with a rated annual capacity

of 1,650,000 tons. (A photograph of a typical line is shown in figure 4). This program was intended to take care of major can requirements in the event that length of the war and attrition of the stock pile demanded the elimination of hot dipped plate.

The need to conserve tin rocketed the development of electrolytic plate. The development took place so fast that a number of difficulties were encountered involving problems in can soldering, enamel adhesion, and corrosion resistance (10). Most of these have been overcome, and today the plate is quite satisfactory from the standpoint of solderability and enamel adhesion.

During World War II inside enameled 0.5 lb. plate, outside either plain or enameled, was used very successfully for many low acid products such as peas, corn, meats, and fish. The use of enameled electrolytic plate was further extended when it was found that for many moderately corrosive products normally packed in plain hot dipped cans, composite cans with enameled electrolytic ends and plain hot dipped bodies performed very satisfactorily. In most instances the shelf life was the same as for cans made throughout from plain hot dipped plate. Products packed in the composite cans included green beans, carrots, peaches, pears, etc...(11)

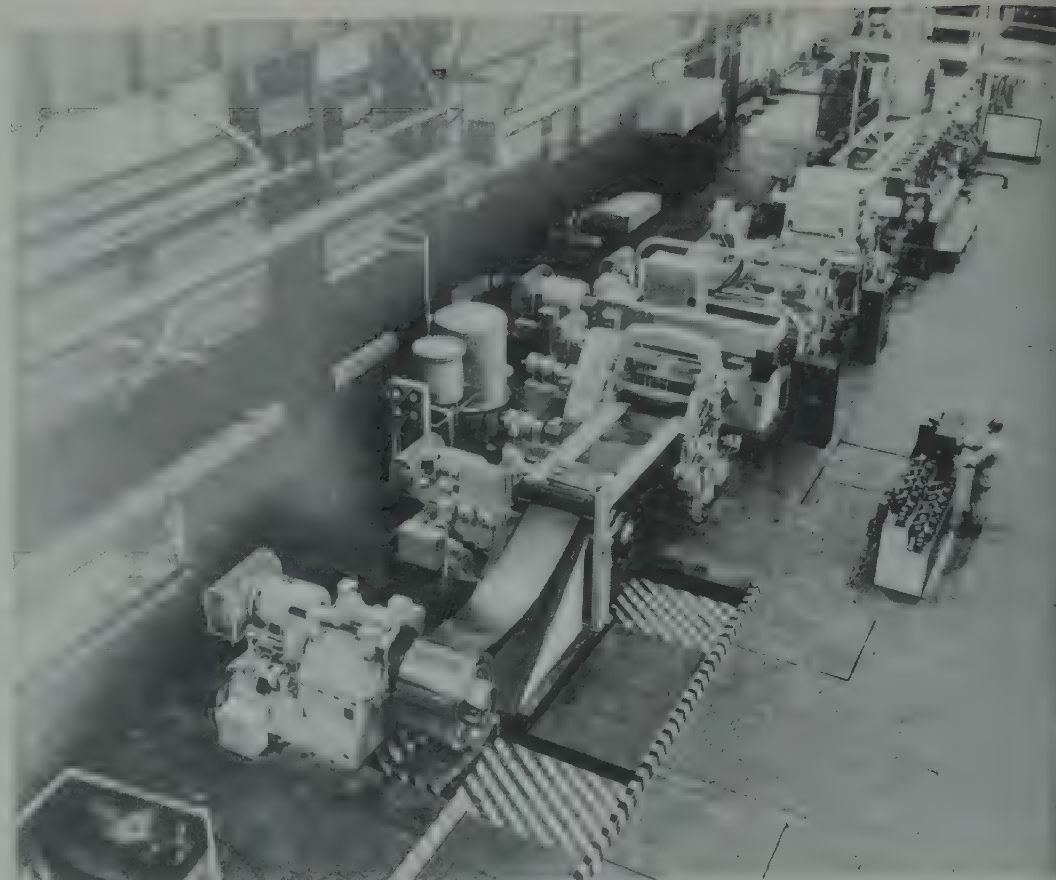

Fig. 4. Electrolytic tin plate line. Electro - plating tin on strip steel. United States Steel Corporation.

The successful experience with enameled 0.5 lb. plate encouraged the trial of even lighter coatings of tin. While the war was still in progress, and to a much greater extent later, 0.25 lb. plate was employed for a number of products. After the war 0.25 lb. plate became the standard plate for beer, pet foods, shortening, lubricating oil, and paints. In the case of some of the non - aqueous products, it is possible to use plain plate, but with all aqueous products inside enameling is required. It is significant that the present order restricting the use of tin specifies the use of enameled 0.25 lb. plate for many of the products where enameled 0.5 plate was used during World War II.

The percentage of plate electrotinned increased steadily in the post - war period as well as during the war years. Table VII shows the relative percentages of electrolytic and hot dipped plate produced from 1944 to 1950 (12).

TABLE VII. PRODUCTION OF TIN PLATE - 1944-1950

Years	Long Tons	Per Cent Electrolytic	Per Cent Hot Dipped
1944	2,605,285	23.2	76.8
1945	2,907,787	29.9	70.1
1946	2,835,830	32.1	67.9
1947	3,710,808	43.1	56.9
1948	3,952,200	45.2	54.8
1949	3,692,823	53.9	46.1
1950	4,752,244	59.8	40.2

The use of 0.25 lb. electrolytic plate, as shown in table VIII, has increased very rapidly in the last two years.

TABLE VIII. USE OF HOT DIPPED AND ELECTROLYTIC PLATE IN CAN MANUFACTURE (13)

Percentage of Total

Years	Hot Dipped (1.50# and 1.25#	# 25	# 50	# 75
1947	47.6	16.8	35.2	0.5
1948	44.5	22.8	33.0	0.6
1949	38.7	35.4	25.4	0.4
1950	35.9	40.6	23.3	0.2

Since 1941 considerable research has been directed toward the improvement of the corrosion resistance of plain electrolytic plate (14). As pointed out previously, all cans made of 0.5 lb. electrolytic plate and packed commercially with aqueous products must be inside enameled in order to obtain adequate shelf life. Many experimental packs of plain cans fabricated from 0.5 lb. electrolytic plate have been made, however, and the results are extremely interesting.

The results show a wide variation in corrosion resistance. Some cans made of plain 0.5 lb. plate have a longer shelf life than cans made of plain 1.25 lb. hot dipped plate of good quality. Others fail in a very short time. It has been found that differences in corrosion resistance exist between edge and center of a particular sheet, and between the head, center, and tails of a single coil of electrolytic plate.

One of us (15) has published examples of this variation in corrosion resistance. In one particular experiment, six different mills were asked to supply ten sheet samples from the head, center, and tail of each of five different coils. At each mill the steel was all from the same heat and each coil was annealed in a different annealing box. The

coils were tinned at two hour intervals, and the orientation of each of the sheets was marked so that it was known which were the top and bottom sides of the strip as it passed through the electroplating bath, and which were the lead edges of the sheets.

Fig. 5. Flip vacuum tester - Determining rate at which cans are failing.

Upon receipt at the laboratory, plain No. 2 cans were fabricated in such a manner that areas from the left edge, left center, right center, and right edge of the top sides of certain sheets were on the inside of the test cans. An equal number of cans were fabricated so that the corresponding areas on the under sides of other sheets were on the inside of the cans. The cans were packed with dried prunes in water and stored at 100°F. Dried prunes were used because they are available all year and because comparative results can be obtained with prunes more rapidly than with other food products. Each week the cans were examined and a record kept of the number of weeks that elapsed before each can failed due to the generation of hydrogen through corrosion processes. A flip vacuum apparatus, used in determining the rate at which the cans failed, is shown in figure 5.

The data obtained showed some very interesting differences between the heads, centers, and tails of certain coils, differences in performance of top and bottom sides of the sheets, and differences between edge and center areas on the same sheet. However, for simplicity, the data are all shown in one frequency distribution curve in which the days to failure are plotted against the number of cans. Figure 6 (p.8) illustrates the wide spread in corrosion resistance obtained in the 0.5 lb. electrolytic plate from the six mills. This wide spread in corrosion resistance of plain 0.5 lb. electrolytic plate has no influence on the shelf life when the plate is inside enameled and used for non-acid foods such as most vegetables, meat, and fish.

Having pointed out the variation that existed in the corrosion resistance of plain 0.5 lb. electrolytic plate, this laboratory joined with the producers of electrolytic tin plate in a comprehensive research program. The plan of attack was to attempt to learn why certain samples gave excellent corrosion resistance, and then to raise the general level of corrosion resistance to equal that of the better samples. If a plain electrolytic plate with corrosion resistance equal to common cokes could be developed, a sizeable savings in the cost of tin and organic coatings would be achieved, even if the plate bore as much as a pound of tin per base box.

The problem of improving and making the corrosion resistance more uniform has proved to be a most difficult one. It has been demonstrated that the variation in corrosion resistance is intimately related to the annealing treatment and that the factors responsible are associated with the steel surface, probably in some way due to oxidation. While no visible sign of such condition may appear on the bright annealed steel, one factor can be demonstrated by measuring the rate of attack of hot dilute hydrochloric acid on a specimen and this phenomenon has been made the basis of a test. An initial inhibition of acid attack denotes presence of the condition and a linear rate of attack with time shows it is absent. Increasing degrees of inhibition in acid attack are considered to show increasingly less desirable steels and the affected layer may easily reach 30 - 40 millionths of an inch. There are still other undesirable, but less easily detectable, surface differences and these are thought to affect the behavior of plain electrolytic plate because it does not receive the same preparation before tinning as hot dipped. Another test has been devised for the finished plate which is considered to give some measure of tin's ability to furnish electrolytic protection to the iron and between the two tests significant correlations with pack performance are secured. In brief, it appears that the technology of the matter is fairly well understood and the major problem at present is to find some economical way of obtaining commercially what is known to make a usable product.

This cooperative research has made significant progress, and, although much work still lies ahead, some cans made of plain 1.00 lb. electrolytic plate will undoubtedly be packed commercially this year. Table IX (p. 8) shows the results of three experimental packs made in 1949 in cans fabricated from lots of tin plate produced from one heat of steel at one mill. The 1.00 lb. plate, and even the .75 lb., is performing quite satisfactorily relative to the hot dipped plate and about as well as electrolytic plate bearing that coating weight of tin is expected to perform. If plate bearing 1.00 lb. of tin or less can be produced consistently with corrosion resistance comparable with the above lots, it should find wide - spread application in the packing of moderately corrosive products.

Development of an electrolytic plate which does not have to be inside enameled may also widen the

field of application of the "differentially" coated electroplates (16). The latest tin conservation proposal, "differential" coatings, are so new that the first samples have just reached can manufacturers. The possibilities of the plates, however, are the subject of considerable speculation.

Successful application of a light coating of tin on the side of the strip which is to be the outside of the can, and a heavier coating on the other side could save large quantities of tin. The amount of tin on the outer side could vary from none at all to 0.25 lb. per base box. In fact, it may be possible to chemically treat the outer side of the steel or plate it with some metal other than tin. The latter type of coatings have been designated "dual" coatings.

The tin coating on the inside of the can might well be 0.25 lb. on plate that is subsequently enameled and used in cans for relatively non-reactive products. When electrolytic plate with proper corrosion resistance can be produced consistently, heavier coatings could also be applied for use in plain cans intended for moderately reactive products.

One of the important technical problems involved in the manufacture of differentially coated plate is a fool-proof method of distinguishing between the sides intended for the inside and outside of the cans. One mill has tried applying a thin film of palm oil in a characteristic pattern from a roller coater to one side of the strip immediately before the melting operation. Because of the difference in interfacial tension, the tin on oiled and unoiled areas melts differently, and the side bearing the characteristic pattern can be distinguished from the opposite side.

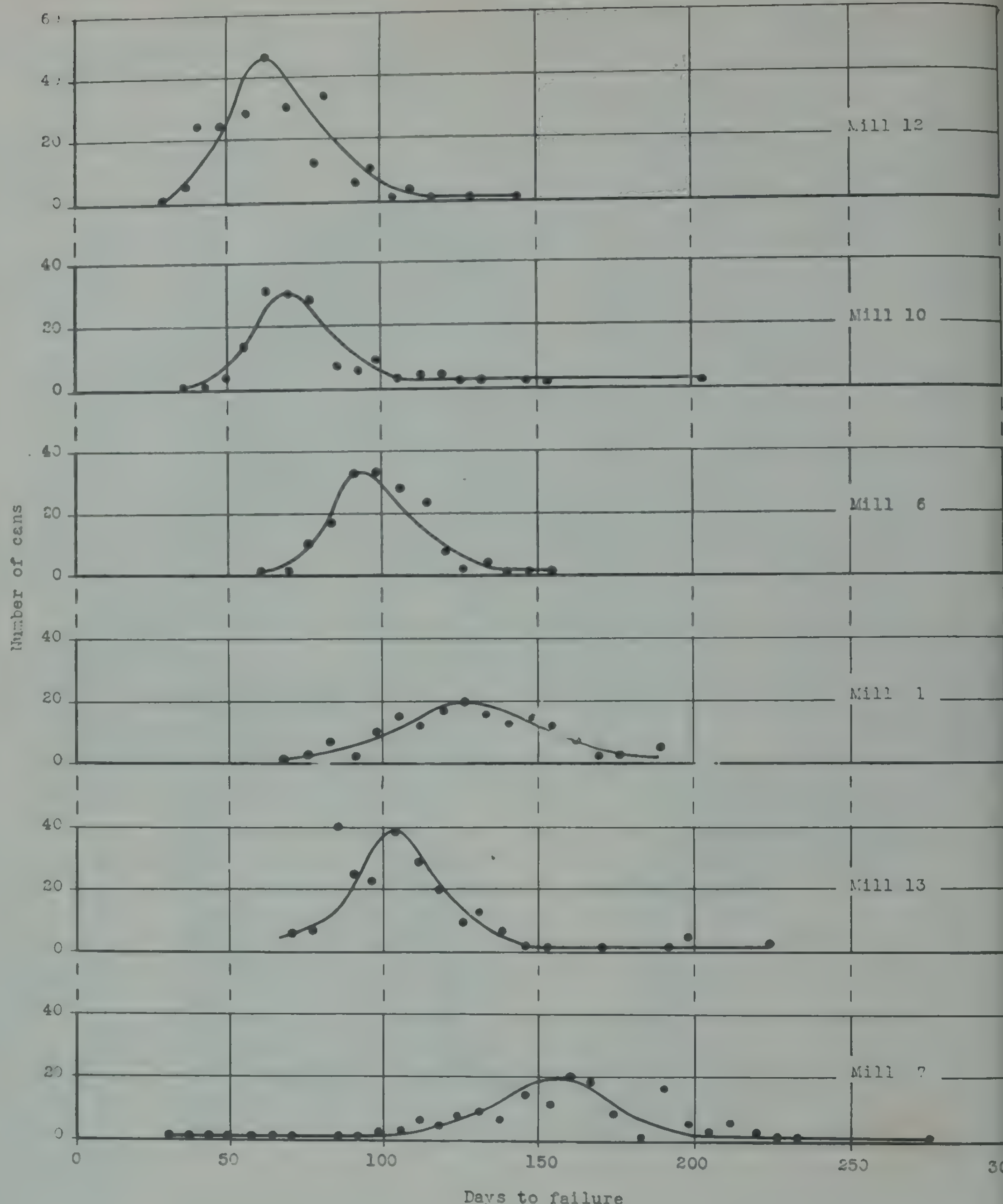

Fig. 6. Frequency distribution curve of corrosion results. Dried prunes in water packed in No. 2 cans made of 0.5 lb. electrolytic plate.

TABLE IX. COMPARISON OF SHELF LIFE OF CANS MADE FROM HOT DIPPED AND ELECTROLYTIC PLATES - Plain No. 2 1/2 Cans -

Product	Plate	100°F Storage: Days to First Failure	100°F Storage: Days to 50 % Failure
Peaches	1.50 lb. (Hot Dipped)	570	More than 570
"	1.00 lb. (Electrolytic)	570	More than 570
"	.75 lb. (Electrolytic)	390	540
"	.50 lb. (Electrolytic)	300	360
Pears	1.50 lb. (Hot Dipped)	510	More than 570
"	1.00 lb. (Electrolytic)	450	480
"	.75 lb. (Electrolytic)	360	420
"	.50 lb. (Electrolytic)	Not packed	

5. Chemically treated and untreated steel

Steel, commonly called "black plate" in the can manufacturing industry, has been used for many years in the United States in the fabrication of pails, lard drums, tobacco cans, and other types of containers. Performance of the plate for these applications has been fairly successful but difficulties of two types have been encountered. The first is the rusting of plate in transit between steel mill and factory or in storage at the latter location. Application of rust preventative oil to the plate is a semi-successful approach to this problem but is not effective under all conditions. The second difficulty is a threadlike rusting of the steel surface underneath the enamel coating under humid conditions. This type of corrosion is best controlled by chemically treating the plate to produce an inert

inorganic film on the surface of the steel.

Untreated black plate, called C.M.Q. in the United States, is not used for can parts for thermally processed food products. Sufficient corrosion occurs at the steel enamel interface with even the most impervious organic films to destroy adhesion. Just before World War II, however, a chemical treatment, the " Bonderizing Process ", was adapted to plate for cans intended for thermal processing (8). It involved passing steel sheets through pressure sprays of a proprietary solution of phosphates, forming a deposit of crystals which adhered tightly to the plate during all can fabrication procedures. The treatment provided an excellent substrate for enamels and also served to control rusting.

The treated plate was successfully used for the ends of cans for corn, peas, meats, and several other products with a pH above 5.5. Due to the difficulty of soldering, usage was not extended generally to the bodies of the cans. Because of the limited applications of the plate, production ceased when additional tin became available after the war.

With the current need for further tin conservation, attention has turned once more to chemical treatments for steel. All attempts this time are to develop a treatment which can be applied continuously to strip.

II. SOLDERS

To conserve tin during the war years, the can manufacturing industry was required to use solders lower in tin content than the 37 per cent tin — 63 per cent lead conventional can making solder. Research quickly established that alloys containing from 30 to 10 per cent tin were unsuitable due to the occurrence of " hot-breaks " and poor creep resistance. Attention then turned to the higher tensile strength solders. (A photograph of apparatus for determining solder flow is shown in fig.7).

An alloy containing 97 - 1/2 per cent lead and 2 - 1/2 per cent silver was used quite successfully during the early part of the war. Later it was found that the silver could be replaced by tin. This "low-tin" solder, containing three per cent tin and the remainder lead, is now used in most can making operations in the United States (17).

The three per cent tin - 97 per cent lead alloy is more difficult to apply than the high tin solder and a number of changes and adjustments on the lines must be made. The side seams are not quite as rust resistant as when 37 - 63 solder is used, but, as shown in tables X and XI, are much stronger.

In this "blow-up" test, a fixture is attached to the can body opposite the side seam and air pressure is applied at a constant rate until the seem fails. Ten cans are included in each lot.

In this creep test, cans packed with beer are stored at an elevated temperature. The pressure of carbon dioxide at this temperature causes creep failure or the seams. As the table shows, cans soldered with 3-97 alloy are much more creep resistant. Another type of creep test, in which air is maintained inside the cans at a constant pressure and the cans are immersed in oil at 250°F. until the seams fail, is shown in figure 8, (p.10).

Fig. 7. Solder flow apparatus.

Lap failure tests, in which empty cans are stacked in storage bins approximately 100 inches high for several months, rarely show any failure of cans soldered with low tin alloy, while from 2 to 200 failures per thousand cans is the usual range for cans soldered with 37-63 alloy.

TABLE X. SIDE SEAM STRENGTH TEST

Solder	Plate	Can size	Blow-up Pressure p.s.i. Min.	Max.	Av.
37 - 63	.50 lb. E	211 x 413 (Beer)	78	103	95
3 - 97	.50 lb. E	211 413 (Beer)	144	157	152

TABLE XI. SIDE SEAM CREEP RESISTANCE TEST (120°F. Storage)

Solder	Plate	Can size	No. cans	Side Seam Failures 1 Mo.	2 Mos.	3 Mos.	6 Mos.
37 - 63	.50 lb. E	211 x 413 (Beer)	48	1	34	48	-
3 - 97	.50 lb. E	211 x 413 (Beer)	48	0	0	0	0

the case of the larger cans, the use of circumferential beads in the can body to increase the resistance to panelling and denting. In the last several years the effect of design and spacing of beads upon panelling resistance has received increasing attention. Table XIII illustrates the increase in panelling resistance obtained by changing the profile and spacing of beads in 404 x 700 cans made of 100 lbs. plate.

Figure 12 illustrates the type of wide, deep beads now employed.

TABLE XIII. PANELLING RESISTANCE OF 404 CANS

Type of Body	Panelling Resistance (lbs. per sq. in.)
Unbeaded	15.5
Old style, narrow and shallow beads ..	24.5
New style, wide and deep beads	36.

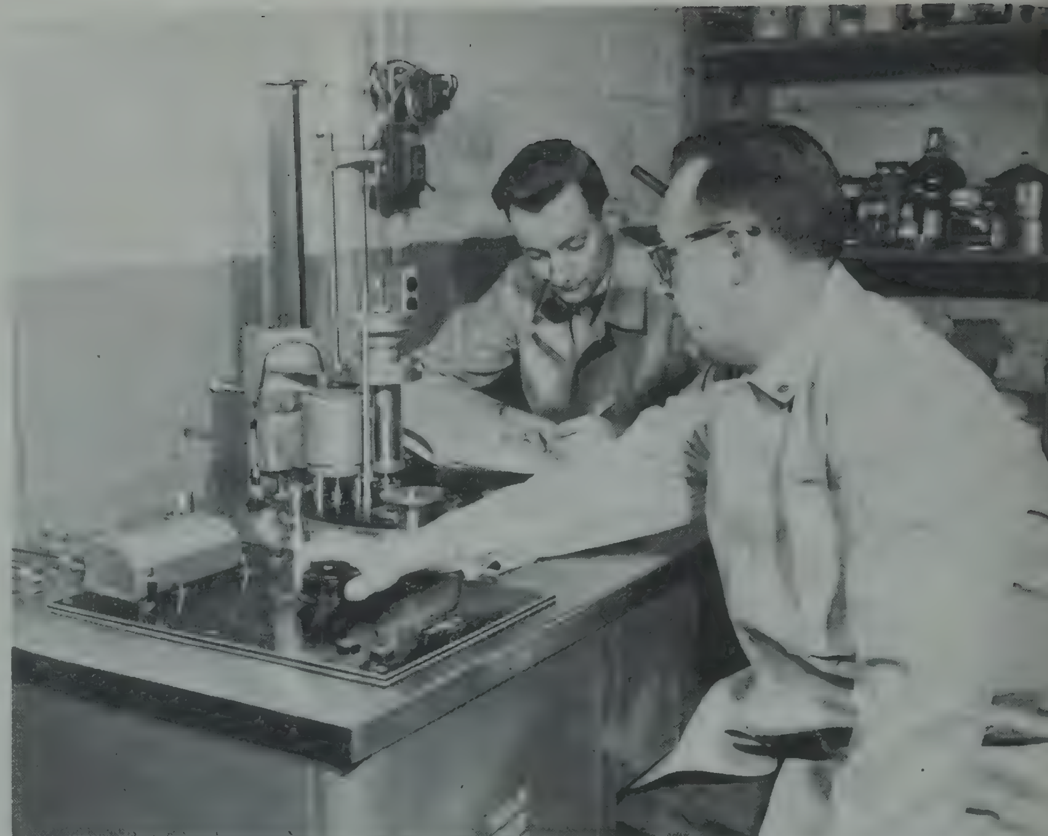

Fig. 11. Monney viscosimeter - Measuring the rheological properties of sealing compounds.

Comprehensive packing and shipping tests have shown that the new design greatly reduces the hazard of panelling cans for tomato juice and other products which are filled into the cans at high temperatures. However, in deciding whether or not to bead cans, a number of factors other than panelling resistance must be taken into consideration, including enamel fracture, solder fracture, reduction in shelf life, and loss in height of can.

VI. SIDE SEAM STRIPING

For many years, dry pack shrimp cans were "side seam striped" on the inside to repair fractures in the enamel coating and eliminate black sulphide discoloration. A thin coating of a rapid drying enamel is sprayed inside the fabricated can body, covering the side seam, and the can is then baked for several minutes in an overhead oven. Many beer cans are also side seam striped to provide additional coverage at a vulnerable area.

Application of a side seam stripe increases the shelf life of reactive products such as cherries, berries, etc... by at least 30 per cent. With a side seam stripe, a longer shelf life is usually obtained with standard coke plate (1.50 lb.) than with unstriped cans made of best cokes (1.70 lb.). Because of the tin shortage, it may be desirable to side seam stripe cans made of enameled 1.00 lb. electrolytic plate. These cans could probably be employed as alternates for unstriped cans made of standard cokes (1.50 lb.).

Table XIV lists the results to date of experimental packs of red sour cherries in cans made of inside enameled standard cokes, common cokes, and striped and unstriped 1.00 lb. electrolytic plate. All four lots were made from the same heat of type L plate at one

Fig. 12. Beaded 404 x 700 cans - Showing differences in bead profiles.

mill. After packing with cherries in a commercial cannery, approximately 50 cans were stored at 100°F. and the remainder at 70°F. The cans were flip vacuum tested periodically to determine rate of corrosion and to remove hydrogen springers. In general, days to 50 per cent failure is a better criterion of corrosion resistance than the time to the first failure.

TABLE XIV. SHELF LIFE OF ENAMELED No. 2 CANS PACKED WITH CHERRIES.

Plate	Side Seam	100°F. Storage		70°F. Storage	
		Days to First Failure	Days to 50 % Failure	Days to First Failure	Days to 50 % Failure
1.50 lb. HD	No	320	421	477	4.8 % - 625 days
1.25 lb. HD	No	194	317	359	21 % - 625 days
1.00 lb. E	No	320	404	440	13 % - 625 days
1.00 lb. E	Yes	434	(2 % failed at 625 days)	(2.5 in vac loss 625 days)	-

The proposal to use side seam striped cans made of 1.00 lb. electrolytic plate is, of course, contingent upon the ability of the mills to produce consistently plate with corrosion resistance similar to the above lot.

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XL. FOOD CAN PROGRESS
(Improved raw materials, manufacturing and handling methods and their results)

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TABLE OF CONTENTS

I. INTRODUCTION

This report deals almost exclusively with developments relating to cans made from steel sheet, mainly tin-plate.

At the first glance one might wonder if such a seemingly simple item as a tin can has undergone any development or is in any state of progress.

One might even be inclined to question if the changes having taken place are really improvements. If a can which has been made say more than fifty years ago, is compared with a can of to-day one will notice that the metal thickness has been reduced as also the thickness of the tin coating.

The ends would probably have been soldered on to the old can instead of having been doubleseamed.

One might argue that the reduction of the steel thickness has reduced the mechanical resistance of the can, the reduction of the thickness of the tin layer has reduced its chemical resistance and that the substitution of doubleseaming for soldering of the ends has increased the risks of leakage. This is also in some way true but the can made by the artisan of say 1880 is technically as well as economically impossible to-day. Only through everlasting persistent development work has the tin can of to-day gained its position, technically as well as economically.

I shall try to give a picture of the more important factors which are determining this position of the tin can to-day.

I should like to stress, that my treatment is not intended to be exhaustive, it is limited by the fact that hardly anyone can give a full picture of what amounts to the developments of the can making industry as well at its "assisting" industries during the last decades. The conditions are still very widely varying from one country to the other. Different canned products, the sizes of the markets, etc... make for example what maybe the right manufacturing method in one place completely impossible in another. Even where new improved methods maybe used, and undoubtedly will be used some day, their introduction may take a rather long time in some places and go quickly elsewhere.

The total picture is thus very inhomogeneous and any person is bound to be biased in his opinions and his evaluation of what are the more or less important aspects of the situation as a whole.

I am thus well aware that my treatment must be superficial, biased and limited in its scope, but hope nevertheless that it will serve some useful purpose in trying to give a survey of the trends in the developments of the tin cans or rather the can making industry, its present status and some of the aspects of the future.

We treat first the "raw materials" or basic components of the food cans, then the manufacturing methods, the handling of the cans in the canneries, the general properties of the cans themselves and finally the research work in progress.

II. BASIC COMPONENTS

1. Tin plate

a. Steel sheet and strip

The most marked improvements here during later years have been the introduction of cold-reduced tinplate. This is being treated in detail in another report and I shall limit myself to the mentioning only of some of the properties of the cold-reduced plate which are of paramount importance to the can-making and canning industries.

These properties are :

1) controlled temper (stiffness);
2) reduced variations in plate thickness;
3) better flatness of plate;
4) more even mechanical properties in different directions on the sheets;
5) improved corrosion resistance;
6) introduction of larger sheet sizes.

The controlled temper has made it possible for can makers to specify more exactly than before the most suitable type of plate for a certain job, from extreme deepstamping on one hand (demanding a soft plate) to manufacturing of ends for very large cans on the other (demanding a stiff plate to avoid excessive thickness of the plate).

The possibility of obtaining, between certain limits, the most suitable plate stiffness for can bodies also reduces the risks of "flutting" i.e. ensures the production of smoothly round bodies instead of polygonal ones.

The reduced variations in plate thickness are definitely necessary to utilize modern high speed automatic can making equipment with full success. This equipment, as mentioned later, is precision-built and also demands precision and uniformity of the mechanical properties of the plate.

Even to-day the variations of plate thickness in the best normal standard tin-plate on the market are large enough to make the can-maker long for and ask for a plate of even more uniform quality, and it is not at all impossible that the tin-plate mills and the makers of the rolling equipment will be able sooner or later to satisfy the can makers and canners in this respect.

The improved flatness of the plate is also of major importance when the plate is to be handled by high-speed automatic can making machinery. This is especially important for the automatic feeding machines which deliver the plate to cutters and slitters as well as to the printing presses for decoration or the roller coaters for lacquering.

The even mechanical properties across and along the sheets have made it possible to a large extent to disregard the rolling directions of the sheets. This gives more flexibility in utilizing the plate for various purposes and contributes to better economy of manufacturing. It is no longer imperative to have the body blanks positioned in a certain relation to either the length or width of the plate depending on the rolling direction.

The improved corrosion resistance is of direct importance to the canner and the ultimate consumer. The cold-reduced plate can be made with a smaller content of certain corrosion-promoting impurities, notably phosphorus, than pack-rolled plate. This has resulted in a definitely increased shelf life of many canned products packed in cans made from cold-reduced plate as compared with packing in cans made from pack-rolled (hot-rolled) plate.

The possibilities of using increased sheet sizes without undue costs have made it possible for the can making industry to increase the output from some of the industry's expensive equipment, especially the printing and lacquering plants.

The larger sheet sizes also make possible more economic combinations of various details to be made from the sheets and thus improve the flexibility of the plate material in production planning and help in obtaining economically satisfactory results.

It will have been understood from the examples given above that the introduction of the cold-rolled sheets and strips has been very important. The production of cold-rolled plate in U.S.A. more or less revolutionized the industry during the years 1933 - 1938 and the last hot-rolled plate was produced in U.S.A. in 1943.

The other tin-plate producers in the world are following the same course and are also gradually re-

placing the hot-mills with cold-rolling equipment. This process has already started some years ago.

b. Tinning

The other important development in the production of tin-plate has of course been the introduction of high-speed electrolytic tin-coating methods.

Electrolytic tinning has been carried out on a smaller scale for quite some time, but the most important step in the development of the electrolytic tin-plate may be said to have been the installation in 1937 of a pilot line at the Gary Tin Mill of the Carnegie Illinois Steel Corporation.

Since then the electrotinplate has become increasingly important and makes to-day out around 2/3 of the total quantity of tin-plate produced in U.S.A.

Erection of electrotinning plants is also going on or is planned elsewhere.

One plant in Great Britain has already been in production for several years.

Electrotinplate was also produced elsewhere, for example in Germany and in Sweden during World War II. Neither the quantities nor the quality can however be compared with what might be called the "American type" of electrotinplate of to-day.

The electrotinplate was originally introduced as a low cost product, the production being made possible by the installation of the continuous cold-reducing mills.

It has however during World War II and may be even more during the last year been the basis of the saving of tin, which is scarce, especially in the United States.

The successful use of electrolytic tin-plate for many canned products has made it possible to materially reduce the consumption of tin for can manufacture. It has thus been stated that whereas in 1941 41,000 tons of tin were used to produce 25,000,000,000 cans, in 1950 only 31,000 tons were used to make 33,000,000,000 cans in U.S.A.

The details regarding electrotinplate are dealt with in another report, and it may be sufficient here to mention only the fact that the improved methods of fusing the electrodeposited tin-film and obtaining a very thin intermediary layer or a tin-iron alloy between the tin-film and the steel base has improved the electrotinplate of to-day, as compared with earlier attempts to make electrotinplate.

Also the chemical treatment to obtain a slight but uniform and protective oxide film and the development of efficient methods to give the finished electrotinplate an exceedingly thin, but however, practically very important oil film on the surface has been very important.

How intricate this last problem is, may be envisaged, when one realizes that it is a question of applying an oil film a thickness of around 1/100,000 of a millimeter, and keeping the thickness of this film reasonably constant.

The last improvement in the production of electrotinplate is the manufacture of differentially tinned plate. This plate has a different tin coating thickness on either side. Tin economy can thus be attained by locating the tin where it is really needed i.e. on the side of the plate which is going to be the inside of the food can, and using only the minimum necessary for rustprotection on the other side of the steel sheet.

The use of the electrotinplate has given the can makers some new problems to solve both when it comes to the printing and lacquering and also soldering, but these have normally been solved without too great difficulty.

The thinner tin-film used, makes inside lacquering necessary for all processed food cans. The possibilities and limitations for the use of electrotinplate for processed canned foods will be dealt with later on.

The uniformity of the tin coating on electrotinplate compares favourably with tin-plate coated by hot-dipping. In the latter case quite large variations in tin-film thickness are normally found even on one single sheet.

2. Sealing compounds

When the ends are joined to the bodies of open top food cans by doubleseaming, a sealing compound of some kind is necessary to make the doubleseam microbetight viz moisture and airtight.

Several types of sealing compounds have been tried, from paper gaskets via rings made of solid rubber, which were "vulcanized" to the periphery of the ends to the liquid sealing compounds which are used to-day in most countries.

The name " liquid " compound may be slightly misleading as the compound is solid when the ends are doubleseamed onto the body or the can. The compound is however applied in liquid state and dried afterwards.

The introduction of liquid compound has been of no small importance in connection with making high speed low cost production of food cans possible.

The cost of compound and its application has been reduced, and uniformity of production achieved.

It is true however that just as the liquid compound makes the production on high speed automatic lines of precision made cans possible, its use also demands a certain minimum of precision and reliability of the closing machines as well as of the persons in charge of them.

The first liquid compounds were based upon natural rubber latex. They have however been developed

further, first by introduction of rubber dispersions and solutions based upon natural rubber, and later by the introduction of synthetic rubber and of "plastic" materials.

Research work is continuously being carried out with a view to further improving the sealing properties of the liquid compounds, their storage properties in bulk, and special types of compound suitable for definite detailed purposes are being tried out by cooperative efforts of compound manufacturer, can maker and canner.

As example can be mentioned the production of oil and fat resisting compounds and compounds especially suitable for can covers which are to be doubleseamed on to cans using injection of super-heated steam in the head-space right below the cover, just at the moment of doubleseaming.

The use of improved types of compound in combination with improved closing machines has undoubtedly been of very great importance in making possible the canning of great quantities of a wide variety of food products with spoilage figures, due to leakage, down to substantially less than 1/10 of a percent. Let it however be said that results as good as these can only be achieved when all links in the production chain resulting in the finished filled and processed can are functioning properly.

3. Interior lacquers

Interior lacquers of different types have been used and are used for protection of the inside of cans for various canned foods.

The object of the lacquering is to protect the natural colour of the product (strongly coloured fruit products), to avoid unsightly staining of the inside of the can (many vegetables and meat products), or to protect the tin and/or iron against corrosive action of the product (many fish products, crustacea and certain acid products).

The canning lacquers have mainly been oleo - resinous lacquers based upon the use of natural drying oils (linseed-oil, chinawood-oil) and natural resins (copal). To obtain protection against staining of the cans due to sulphurcontaining products small quantities of zink oxide are added.

This " original " type of can lacquer is still used. The demand for improved quality characteristics as : better adhesion to the plate, a more perfect coverage, better fabrication properties, a harder and tougher and more impermeable film, better flavor characteristics etc,has led to a great a many improvements in later years. Quick baking of the lacquer on the sheet is also of great importance to utilize the lacquering and baking equipment in an economical way. The demands on the quality of a lacquer are twofold and in a way contradictory. To obtain optimal protective properties for a certain product for a given type of can produced on a given type of equipment, a highly specialized type of lacquer may be desirable or even necessary. On the other hand is the reduction of the number of different lacquers to be held in stock also in many ways important. This means that there is also a demand for what one might call a "universal" lacquer.

These demands have led to the development of very many different types and qualities of can lacquers. New drying oils like dehydrated castor oil have been used and also synthetic resins of widely varying types and properties.

It will be going too far to try and give a detailed picture of these various and varying types of lacquers here.

Some new types of practical interest may be mentioned. One is the phenolic type. The pure phenolics are chemically very resistant and impervious. They have therefore very good "sulphur-protecting" properties without any addition of zink oxide.

They are however not very suitable for deepdrawing purposes and they are rather sensitive to the surface conditions of the tin-plate. Adhesion of phenolic lacquers to oxidized tin-plate can be rather poor. They are mostly used for solid meat packs but even for fish products. Special types of slightly modified or even pure phenolics are being used for deep drawn cans for sardines in U.S.A. and the corresponding brisling packed in Scandinavia.

Vinyl-type lacquers are being used for several special packs, notably for beer packed in flat-top cans in U.S.A. due to their very good flavor characteristics. The vinyl lacquers are even very pliable and stand deep drawing well. Some of them have rather poor adhesion but great improvements have been made in this respect. They were originally also prone to disintegration upon prolonged heating on tin-plate but this is being overcome by addition of stabilizers.

Use has even been made of the fact that one can make lacquers being mixtures of two different types which after being applied to the plate will segregate or stratify so that a layer with good adhesion properties lies next to the metal whereas the other component e.g. showing very good flavor characteristics lifts to the surface of the lacquer layer.

Recently some special resins of the socalled Epon and Geon types are being investigated for their suitability as canning lacquers either alone or in mixture with other resins. They are however to-day rather expensive but seem to offer interesting properties.

4. Outside decorating materials

The outside decoration of food cans which are not to be processed does not offer any problems apart from the ones accompanying normal tin-plate decoration. But the manufacture of food cans with outside decoration with designs of the same type as can be had on paper labels, and which stands successfully up to the very severe processing conditions that may be encountered, presents a great many problems.

The demands to be met are :

1) no complications in the decorating process;
2) good gloss after processing;
3) no changes in appearance of colour or bleeding of colours;
4) no peeling, blistering or other similar faults;
5) sufficient hardness of surface to withstand a reasonable amount of handling.

Decorated cans with designs of a rather simple type, a limited choice of colours and colour shades and printed directly on the tin-plate have been made and used for a good many years. Also more elaborately decorated cans for processing at rather low temperatures and short times. Decorated cans using a white coating or similar base and allowing the use of the modern methods of naturalistic colour reproduction of almost any motive, are however a fairly recent development.

They are to-day becoming of increasing practical importance in several countries, both in the Western Hemisphere and in Europe.

Such decorated cans are now available which will withstand processing at temperatures of up to 120°C, for several hours in steam retorts. Corresponding processing in water filled retorts presents an even more difficult problem as the properties of the water can vary very much from one water supply to the other. Cans that give an entirely satisfactory result in one place may be a complete failure under other conditions of water supply. Work is going on however to solve also this problem.

So far the decoration problem is really completely solved only for the can bodies and to some extent normal can covers.

An entirely satisfactory system for process resistant decoration of deep drawn cans, with the same optimum properties as described above does not yet exist but it may be said that this problem is also very probably near its solution.

The development of the process resistant decoration has meant the elaboration of new coatings, new protecting finishing varnishes as well as new special printing inks and has thus made necessary the coordinated efforts of manufacturers of lacquers as well as manufacturers of printing inks and the can makers.

III. MANUFACTURING METHODS

I. General

The recent developments in can making machinery and manufacturing methods can be described in three words : speed, precision, economy. High speed precision equipment is now available for most of the different steps in can manufacturing.

The two first conditions can therefore theoretically and technically be satisfied but the simultaneous fulfillment of the third condition, the economy, may many times limit the possibilities of a free choice between the most efficient machinery available, due to its cost and the need for very long runs to make the equipment pay.

This is one very important reason why standardization of can types or rather what is often called simplification is becoming increasingly important. A reduction in the number of different can sizes and types to be made is very important, especially the reduction of the number of different can diameters, as the change over from manufacture of one type of can to another means changing of the settings of the large number of different machines making up a modern can making line. A reduction in the number of different cans to be made will also simplify the task of keeping in stock tin-plate of suitable quality and dimensions to ensure maximum economy and minimum can prices.

The attempts that have been made after the war to try and establish an international standard of food cans are therefore of great importance not only for the protection of the consumers against fraudulent practice, and in the international trade, but even for the can manufacture.

It may even be worth while mentioning that such international can standardization may be of importance for the manufacture, import and export of can making as well as canning machinery, facilitating the specification of the machines for the buyer.

There has been a constant improvement and development work going on on nearly all types of can making machines. The results have been utilized to different degrees in different countries and for that reason, many of the machines which are going to be mentioned here may be well established standard equipment somewhere, notably in U.S.A., whereas they represent rather late developments as far as other countries may be concerned.

Cutting machines of different kinds as scroll shears, rotary plate slitters etc. working with automatic feeding machines have been improved as to speed and precision.

The same holds good for the automatic bodymakers, the can body-forming machines which have replaced or are replacing to a very great extent the older and more laborious methods of body-forming in most countries.

The current design of such machines is rather similar for most makes even if differences occur on many details to suit particular purposes.

The production capacity varies, but for normal sizes of open top cans production speeds of 250-350 cans/minute are normal, and even higher speeds are being used in some places.

The use of reduced tin coatings and even tinfree plate, blackplate, has made several changes in construction details necessary. It has recently been announced that successfull high speed soldering of blackplate can bodies now can be carried out.

The punch presses for making the ends and also for making deep drawn cans for special products have been improved and the old hand-operated presses making 50-60 details per minute replaced by presses capable of making up to more than 600 details per minute.

The high outputs to be achieved have both demanded and also made economically possible the use of improved dies, flange curling apparatus and other details resulting in the production of cans ends and deep drawn cans of better uniformity than before.

This has been necessary to cope with the problems of successful handling of the ends in the other fully automatic equipment they have to pass before the finished cans with their contents are presented to the customer.

The development of new sealing compounds has already been mentioned. Hand in hand with this has gone the improvement of the automatic machines for application and drying of the compounds.

Some of these machines have also an output of nearly 600 ends/minute comparable with the production of the punch presses.

The closing machines for double-seaming of the bottom end onto the body at the can factory and the corresponding machines used in the canneries for applying the covers to the cans, have also been improved with a view to attaining higher output, less manual labour and increased precision and uniformity in the seaming operation.

Double-seamers are now made operating at speeds close to if not exceeding 400 cans/minute.

These are of course equipped with automatic feed of the covers and with special features to minimize the risks of the cans jamming in the machines and causing production stops, and are generally constructed to give long time runs with consistently good results with a minimum of changes and extra adjustments of the machine settings.

It is becoming more and more apparent that the can making equipment of to-day is really being developed into what might be called high speed precision instruments rather than anything else.

The differences in the products made may not be apparent at the first glance, but a thorough investigation of a finished can or rather of a large number of finished cans will beyond any doubts reveal the fact that the dimensional variations of the different parts and details of the cans have been materially reduced, and thus the possibilities of keeping a constant high level of quality increased by the use of modern can making methods and equipment.

The methods of can making have changed from those of craftsmanship to those of scientific engineering and the can from a product of handicraft into an engineering job.

2. Special

We have briefly been surveying the progress in the general methods of can making and the equipment used.

A similar progress has also been made when it is a question of specialties like inside lacquered and/or outside decorated cans.

The printing machines as well as the lacquering machines and the driers have been improved to obtain higher production capacities, more uniform coating films and to handle the larger sheet sizes which are now available.

Tandem printing presses are becoming more usual and even 4 colour printing press combines are being used for tin-plate printing. Also application of the finishing varnish directly to the last print without drying, is being used, thus saving one pass through the driers.

Equipment for economical post-lacquering of the most important areas of the cans, notably along the side-seam, has also been developed. This equipment which forms an attachment to the normal automatic bodymaker and side-seam soldering machine permits the application of a narrow stripe of lacquer right along the side-seam, where the lacquer applied to the whole plate is likely to show cracks, and where also the raw cutedges of the "laps" in both ends of the side-seam else might get into contact with the canned products.

This side-striping equipment was mainly developed for beer cans but has also been used for manufacture of cans for certain other products which are very sensitive to direct contact with metal.

The outside of the side-seam may also in some instances be lacquered in a similar way.

Another means to improve the continuity of the internal lacquer coating is to apply, by spraying, a stripe of lacquer to the periphery of the end (the shoulder of the end), where fractures of lacquer as well as tin coating may take place due to the deformation of the metal during the manufacture of the ends on the punch press.

These locations in the can are the ones where localized attack by strongly corrosive products is most likely to occur, and test packs with a variety of products have shown beyond any doubt that the storage possibilities can be substantially increased and the risks of pitting decreased by the use of such "locally post-lacquered" cans.

The side - striping can be carried out at high - speed and the end-spraying can undoubtedly also be stepped up in speed if the demands from the customers make the production of these "special class" cans economically possible in large quantities.

A still further step is the inside spraying of the whole can body or even the completed can (body

and bottom end) or alternatively dip-lacquering or spin-lacquering.

These methods may give an even better chance of full protection of the metal surface than " local-post-lacquering " but are rather expensive.

This principle is being used for the production of beer-cans in U.S.A. and in Germany, and for products like grape-juice in France. It was extensively used in Germany during the war.

Normally very large quantities of the same can size are needed to make this type of production economical.

The object of these special lacquering methods is of course to obtain a practically perfectly continuous film and reduce the area of exposed metal to an absolute minimum.

In order to obtain really satisfactory results very great care must even be exerted in the canneries as the double-seaming of the covers else may result in the formation of cracks in the protective lacquer-film. For this reason special seaming chucks and seaming roller profiles are used and extreme care taken that the cover does not rotate relative to the can during the seaming operation as this might cause frictional molest of the lacquer film.

3. New principles

Even if the presently used method of soldering can bodies is fairly well "standardized", other methods have been and are being tried. The most important one seems to be the welding of side-seams. This methods was originally introduced for the production of can bodies from blackplate, but is being tried also for tin-plate. Low speed welding does not offer any very special problems apart from the general problems encountered in welding of tin-plate. The demand for high speed production introduces however many new problems and has made the construction of special side-seam welding machines necessary.

The method is not new. It was used quite a few years ago in U.S.A. with production speeds of somewhat less than 100 can bodies/minute.

The welded cans have had greater practical importance in Germany and machines are said to exist having a capacity of above 100 bodies/minute.

The possibilities of making such welding machines capable of making can bodies at about the same rate as the automatic side-seamers with soldering attachements are at the moment being seriously investigated.

Another development which was originated by the necessity of tin-saving has been the use of low tin solders.

By low tin solders one understands soldering alloys containing less than about 5 % tin, often down to 1 - 2 %, the rest being lead. The normal high-tin solders have usually contained about 40 % tin.

The low - tin solders show in some respects improved quality properties, which make them of general importance.

The " laps " at both ends of the side-seams are definitely stronger than corresponding laps on can bodies soldered with high-tin solder, probably due to the increased creep strenght of the solder. This fact makes possible a material reduction of the risks of spoilage due to "weak laps".

Extensive research work carried out especially in U.S.A. and in France has shown that there are no health risks involved.

It has actually been shown that even if lead is dissolved in a product, or soluble lead compounds added to it, the lead after a short time of storage will be " plated out " on the can, and small amounts of tin and/or iron dissolved in its place, the latter not being in any way dangerous to the health of the consumer.

Recently experiments have been carried out aiming at replacing the solder by some kind of "plastic" cement in the side-seam, the object being saving of solder metal.

No reports exist however showing successful use of this method of making the side - seams for cans for processed food products.

4. Quality control

The trends in the developments of the can making machinery into precision instruments as mentioned above have carried with it the possibility and also the necessity of an improved quality control in the can factories.

The dimensions of the can components are thus maintained within very narrow limits. The same is true of the amounts and quality of the sealing compounds used on the ends and of inside lacquers etc.

Automatic can testers are important parts of modern can making equipment too, helping the can maker in keeping his machines properly adjusted.

But apart from the use of the automatic testing machines further control is exerted by thorough investigation of random semples of the production.

The necessity of destructive inspection of these samples makes of course a so-called 100 % detail-inspection impossible and the low-cost per can and large quantities of cans produced accentuate this impossibility.

For this reason the use of modern quality control methods, notably the so-called statistical quality control has been and is being adopted to can making.

These methods are very well suited for this particular kind of production, and the results obtained where such methods have been used are generally very satisfactory.

The same methods can also easily be adopted to many steps of the canning procedure.

I may mention from personal experience the fact that introduction of statistical quality control of the double-seaming of covers in several canneries has materially reduced the proportion of spoilage.

IV. HANDLING IN CANNERIES

The food cans have not obtained their final appearance, are not finished, until the cannery has double-seamed the cover onto the can. For this reason the canners, and the methods they use for handling are partly responsible for the quality of the cans and the ultimate success and progress of the food cans.

Great improvements have been made and are still being made in efficient handling of the cans.

Transportation of empty cans from the can maker to the cannery and in the canneries has been modernized. The use of modern filling equipment helps to maintain a constant fill and reduce the risks of buckling of the cans due to overfill.

The automatic double-seamers in the canneries present a definite improvement in the double-seaming operation, and the use of high-pressure retorts or at least pressure cooling is of importance in reducing the mechanical stress on the cans during processing and cooling, thus also assisting in obtaining an improved final result.

The pressure cooling and high-pressure retorting demand however better double-seaming than air-cooling and one may say that the use of these processing methods have only been made possible by improvements in the can closing operation.

The high-speed handling of the closed cans in mechanical unscramblers and dropchutes etc. while increasing the factory output has introduced the problem of can abuse, and increased risks of leakage due to dents and blows on the cans, especially on the double-seams. The hazards involved have been mastered partly by the use of sterile (chlorinated) cooling water and partly by improvements of the sealing compounds and the closing machines and their operations.

V. FINAL RESULTS

1. General requirements

The final results asked for are of course cans which will give a minimum of spoilage due to any kind of leakage and a maximum shelf life at the cheapest possible price.

The optimal solution of this problem depends as we have already seen on a good many different factors. The solution may even be different from one product to the other, the price of the product determining how far it is economical to go in trying to produce a technically perfect can. The market conditions may also be of importance in this respect, because they determine the rate of turn-over in the stores of the grocers and thus the minimum shelf life demands to be met.

It is therefore hardly possible to give in a few words à generally valid statement as to what general requirements can be met by the average quality of food cans capable of being produced to-day.

It is thus i.e. only possible to utilize the special corrosion resistant types of tin-plate, which give maximum shelf life for certain products, but which are more expensive than the "Standard quality" tinplate, if the demand for such cans in given sizes etc.. can be reliably estimated.

2. Special requirements

From a purely technical point of view, disregarding all the problems met with when it comes to the practical realisation of the theoretical technical possibilities, one may however say that the development of the cold-reduced tin-plate has made possible definite improvements in corrosion-resistance of the cans and shelf-life of the products.

The reduced tin coating weights which have enforced themselves in several countries and the problems they have introduced have in general been successfully met by improvements in canning lacquers and lacquering procedure.

The most important change has been the introduction of the electrotinplate, and even here extensive research work, which has been carried out in many countries, has shown that cans wholly or partly made from electrotinplate with a suitable inside lacquering can be successfully used for the majority of non-acid food products.

For acid products, fruit and berries, pickles etc. the use of electrotinplate is generally not recommended. It can be used however for ends for cans for not highly coloured fruit like apples, pears, peaches etc. The risks involved using electrotinplate for other fruit products is mainly the tendency to discolouration of the products when in direct contact with metal, and the development of hydrogen swells and perforations.

For vegetables, lacquered electroplate may be used, at least partly, in most cases, with the exception of products like asparagus or onions and sour products as pickles, rhubarb and sauerkraut.

In the cases mentioned above N.50 electrotinplate is the quality, which has been accepted for use.

For many vegetables lacquered ends are used, made from electrotinplate No 25. Examples which may be cited are green beans, wax beans, carrots, cauliflower, leafy green vegetables, mushrooms, potatoes and even some tomato products.

For products like corn and peas No 25 electrotinplate can be used even for the can bodies.

For most fish products No 50 and/or No 25 electrotinplate can be used and even for the majority of meat products.

Details on the use of electrotinplate for food cans may be found in the can order M-25 issued by the National Production Authority of the U.S.A. Published results of investigations by the Research Institute of the Norwegian Canning Industry show in general results, which correspond quite closely to the American regulations.

The question of if the electrotinplate can be used as a successful substitute or not in a given case, can normally not be answered with an unconditioned yes or no. It will always be a matter of personal, subjective judgment as to what is "satisfactory" and what is not, as no generally accepted objective standards exist or methods of measuring the "quality" as such.

In some instances cans are demanded to have very special properties, notably a very low metal exposure. The problems encountered in the manufacture of such cans have already been mentioned.

The most important type is the beer can. The product is here extremely sensitive to contact with metal. Only a few parts per million of dissolved metal (tin or iron) may cause cloudiness, off-flavors etc.

Similar problems are encountered in the manufacture of cans for products like, grape juice and for various types of carbonated beverages.

With the exception of the grape juice, these products lie outside the usual domain of the cannery. These special types of cans are however worth mentioning as corresponding modifications of the can manufacturing methods may be used for making "special quality" cans even for difficult "usual" canned products.

The practical possibilities are here however, as already mentioned, governed not only by what is technically possible, but probably even more by what is economically feasible.

Other special types of cans have been developed and a rich flora of patents exist. Only few of them have so far been of practical importance. Many inventions relate to easier opening of cans.

Cans with very carefully scored ends, which are supposed on one hand to withstand the processing conditions and on the other hand to be easily opened by a pen-knife have been rather efficiently advertised but do not so far seem to be made on any large scale. Food cans with "reclosable" covers of various types have also been patented and a lot of intended improvements of the can opening procedure, partly relating to new can openers and partly to special designs of the cans themselves. A recent patent may be mentioned, which covers the use of an explosive introduced into the seam to make the can blow off the cover when heated.

Other patents cover self heating cans for military or camping purposes.

None of these special features seem however to be of great importance for cans in general usage. The most important development relating to the ease of opening of cans seems to be the "on-the-wall" type of can openers, which are becoming very familiar.

They have been so successful that it is not unusual to see sardine cans with tongue-covers (either the deep-drawn or the ones with soldered-on covers) being opened with such openers instead of the keys.

Improved types of key opening have also been reported but have not as yet replaced the conventional type.

VI. RESEARCH IN PROGRESS

Research work is going on in can makers laboratories in the various countries. It covers among many other things such problems as the general mechanical conditions for making and forming the cans, the relation between the engineering design of the can-making equipment and the cans, and their strength and ability to withstand the conditions encountered in the canneries.

Often the closer investigations of details of the manufacturing methods and machines by the aid of modern instrumentation has made it possible to study important details more exacting than before and thus obtain a more fundamental knowledge of the process. This can result and has resulted in definite improvements and changes in methods that originally were developed by the "hit and miss" approach but which can now be "tailor made" to suit more clearly defined fundamental requirements.

One may in this connection mention the study of the soldering operations and also the double-seaming performance. Both these functions were originally developments of the work-shop practice and have only rather recently been made the objects of detailed study.

Even practices which to-day are definitely established ones are in the laboratories and engineering development departments being questioned and fundamentally new answers to old problems tried.

New sealing compounds and new lacquers etc. are constantly being tried out and research work is also being done on improving and/or creating methods for evaluating the quality of such products.

Quite extensive work has been necessary especially on methods making it possible to obtain quickly and with a minimum of labour, reliable indications of the "service quality" of cans.

There are still many problems to be solved in this particular field and it is doubtful if a general solution can ever be found. The fact that the cans are actually delivered semifinished to the canneries and must be expected to be exposed to very widely varying treatments, filled with differently behaving products and stored under very widely varying conditions, indicates, that practical test packs and subsequent time-consuming storage control are at least still necessary to obtain fully reliable results as to the performance of the cans. But even if the test packs maybe never will be completely replaced by " quick-tests ", many methods have been developed and are being worked out that undoubtedly will make predictions of service quality from quick tests more and more reliable. This in turn will help both the can making and the canning industry in keeping a high standard of quality on their products.

Among other research achievements that have partly already reached the stage of practical use may be mentioned the use of the double - seamed pear shaped ham cans with compound seal without subsequent soldering.

Other cans may also be worth mentioning even if they are not "open top" cans in the usual sense of this word. Such cans are the socalled Aerosol cans, which are also used for food products as whipped cream as well as the pressure packed coffee can and shortning cans. The latter is chiefly used in the United States.

Long range research work is also being carried out on the problems of optimal processing conditions with a view to try and improve the cans as well as the canned products so as to further steadily the popularity and the consumption of canned food products in general.

XLI. THE DEVELOPMENT OF ALUMINIUM CANS

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I. GENERAL SURVEY

The first experiments to introduce aluminium containers in the canning industry started in Norway. In 1916 the Norwegian Aluminium Company (NaCo) founded an aluminium mill in Höyanger in Sogn, and in 1919 Nordisk Aluminium Industri (N.A.I.) built a rolling mill for aluminium in Holmestrand. Plans were soon formed to utilise a part of the capacity of the rolling mill for production of strips to the canning industry. The material used was pure aluminium with 99.3 - 99.7 % of aluminium (2S). As it is difficult to solder aluminium in the same way as tinplate, it way only natural that the experiments were based on deepdrawn cans.

During the first years a lot of canning experiments were carried out, mainly with the principal Norwegian export products, brisling and sild-sardines, as well as kippered herrings. The attempts were at first not too successful, the reason for this chiefly being the poor elasticity of aluminium. During processing of canned goods the vapour pressure in the retort will balance the vapour pressure inside the cans, provided there is equilibrium of temperature. But in addition there also is a superpressure in the cans, due to the air present, and the result will be outward bulging of the cans. After cooling tinplate cans will resume their original shape, owing to the elastic properties of steel, but the bulging will remain in aluminium cans. Attempts were made to overcome this difficulty, partly by using thicker strips, and partly by corrugation of bottom and cover of the cans. It was, however, first in 1930, when the superpressure retort came into use, that the socalled physical swelling was finally mastered. In the superpressure retort the air pressure in the cans is counterbalanced by an extra pressure beside the steam pressure. The additional pressure is obtained either from compressed air in steamfilled retorts (system Rydberg-Petterson) or from waterpressure in waterfilled retorts (system Kvaerner Brug or Hamar Jernstöperi).

But beside the physical swelling of aluminium cans it was soon evident that there were also corrosion problems to be considered, in the first instance regional corrosion with formation of hydrogen. This form of corrosion naturally enough mostly occurred in acid products, such as fruits and berries, but was also encountered in almost neutral goods, f.i. brisling-sardines in oil, meat balls in bouillon, several kinds of vegetables, especially spinach etc...

An important step in advance towards conquering of the corrosion problems was the development of the anodizing process (+). This is a process to strengthen the natural oxide film on aluminium by anodic oxidation. Much preparatory work had been conducted, chiefly in Germany and Great Britain, but the plant erected in 1939 at the mill in Holmestrand for continuous anodizing of aluminium strips was the first of its kind in the world. Later on 3 more plants were built, with a total capacity of 3,000 metric tons of strips a year. Further expansions are planned, which will increase the production of anodized strips to about 3000 tons yearly.

(+) In Norway called Eloksal-process (from <u>El</u>ectrically <u>ox</u>idised <u>al</u>uminium)

The anodizing represented a considerable protection against regional corrosion, but some products, f.i. kippered herrings, had a pronounced tendency to pitting, even in anodized cans. It was therefore attempted to produce an alloy more suitable for such products than 2S, and finally the alloy 3S (not anodized) containing 1.0 - 1.3 % of manganese, was chosen for this purpose.

To increase the resistance to corrosion of the can material still more, also lacquering of the anodized strips was tried, employing the usual can lacquers. The most effective method, spray lacquering of the finished cans, was abandoned for economical reasons, and in the beginning sheet lacquering was attempted. The anodized strips were cut into sheets, and lacquered and stoved in the same way as tinplates. This procedure was of course technically unsatisfactory, since the rest of the production process was continuous, but before the last war it was difficult to build a satisfactory plant for continuous lacquering of strips. Such constructions were certainly known beforehand, but as the lacquers then at disposal polymerized slowly, the lacquering stove must have pretty large dimensions. Later on it was possible to obtain synthetic lacquers which polymerized more quickly, and in 1948 the first plant in Norway for continuous anodizing and lacquering of aluminium strips was a fact.

The introduction of the continuous lacquering saved one step in the production process. The oxide film obtained by the anodizing is very porous and has to be sealed one way or another. In the original process this was done by treatment of the anodized strips with hot water, but later on the lacquer was used for this purpose. In this way a lacquer - film adhering very well to the surface of the metal was obtained, and by saving of the water sealing the production costs were so reduced that the lacquered strips could be sold at practically the same price as previously the unlacquered ones.

TABLE I

Material	Ultimate strength kg/mm²	Yield strength (Set 0.2%) kg/mm²	Elongation %	Hardness Vickers HV kg/mm²
2S annealed	9	3.5	35	22
2S hard rolled	15 (13.6)+	14 (13)	5	47 (42)
3S hard rolled	18	17	5	54
B 50 S hard rolled	21.8 (20.8)++	- (19.5)	1.8	67 (63)

(+) The figures in brackets refer to sealing lacquered material.
(++) Now 27 (22.8).

Parallel to all these experiments to overcome the corrosion problems, much work was also done to improve the mechanical properties of alumunium. Previously a lot of alloys had been investigated in an attempt to improve the corrosive properties of aluminium, but except in the case of 3S, without much success. From a mechanical point of view, however, the work with alloys was more promising, and in 1950 N.A.I. succeeded in producing an alloy (B 50 S) containing about 0.6 % of magnesium, and being mechanically much stronger as well as considerably more elastic than 2S.

Table I shows some physical constants for various kinds of aluminium strips. The first three columns refer to tension at right angles to the rolling direction.

To get an empirical impression of the mechanical resistance of aluminium cans, an empty round 1/2 can (108 x 54 mm) is covered with a thick iron sheet, which is then loaded till :

1) the flange gives in, and
2) the side of the can breaks down.

For comparison the following data are given (Table II).

TABLE II

	2 S sealing-lacquered	B 50 S sealing-lacquered
1)	175 kg	240 kg
2)	275 kg	420 kg

II. THE PRESENT PRODUCTION PROCESS

We will now follow the production process as it is carried out at present (fig. 1).

From the works in Höyanger the aluminium arrives at Holmestrand as ingots or slabs. The ingots are molten at the rolling mill with aluminium scarp to slabs, so that only slabs enter into the production. The slabs are about 120 - 140 mm thick. They are first preheated to 450 - 500°C and then pass through a hot rolling stand, where the thickness is reduced to 10 mm. This is the only hot rolling operation; all subsequent rolling is cold reduction. After cooling the slabs pass in rapid succession through a rougher roller and a prerolling stand, and the resulting strips are now so increased in length, that they have to be wound into coils.

The next step in the process is annealing of the coils at 400-500°C in an electric oven; after cooling and uncoiling the strips go through a temper rolling, which give them their final properties as to hardness and thickness. The last operations are trimming in a slitting machine and coiling, and then the coils pass on to the store rooms.

TABLE III

0	annealed
1/4H	one quarter hard
1/2H	half hard
3/4H	three quarters hard
H	hard

The finished strips have a hardness and a thickness adapted to their

intended use. For hardness N.A.I. has introduced the following abbreviations (Table III).

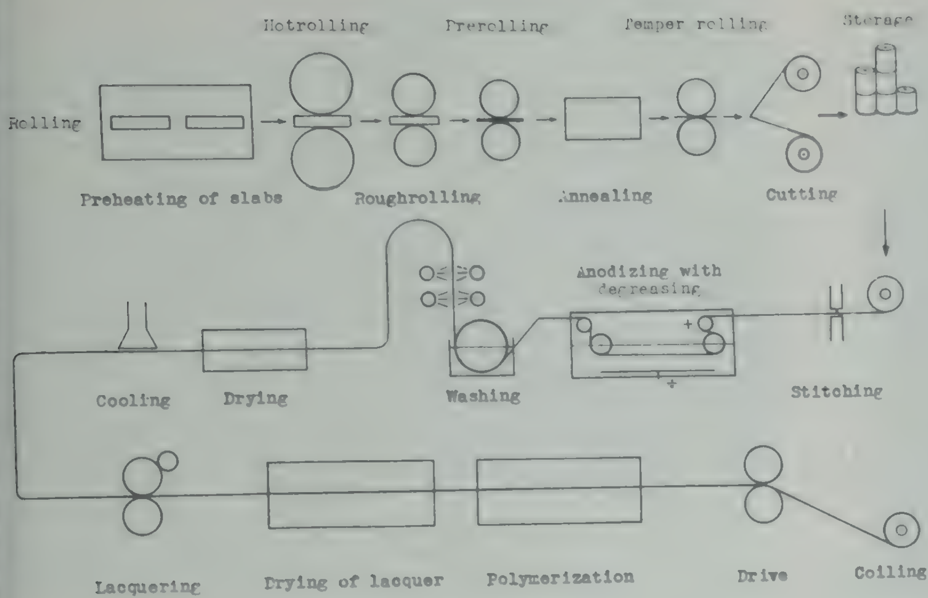

Fig. 1

For strips to the canning industry 3/4 H and H are being employed, the former less hard material for the cans, which have to stand the strain of the deepdrawing, and the latter for the covers.

The thickness of the strips varies according to the size of the cans (Table IV)

TABLE IV

Can size	Thickness in mm
1/1 round can (137 x 68 mm)	0.42
1/2 " " (108 x 54 mm)	0.36
1/2 obl (155 x 61 x 29.5 mm)	0.36
Smaller cans	0.325

The gage variation for thickness ought not to exceed ± 0.025 mm and for width ± 0.6 mm.

From the store rooms the strips go to the anodizing process. They are uncoiled, and to make the process continuous each strip is stitched together with the following one. Earlier there were two steps in the process, first degreasing and pickling in one vessel, and afterwards the anodizing in another one. Now degreasing, pickling and anodizing take place in the same vessel, according to a method by Dr. SONNINO in the Swiss firm Fabrique d'Emballages Métalliques S.A. The vessel is made from iron with an inside covering of lead, and with aluminium cathodes. The anodic current is supplied through a contact roller. The bath consists of sulphuric acid of 15 - 25 % strength. For degreasing an emulsifyer is employed. The time of the electrolysis is about half a minute, and the velocity of the strip through the bath is 12.5 m/min. The desired thickness of the oxide film obtained in this way is about one μ.

After the electrolysis the continuous strip passes through a water bath and a hotwater shower to remove sulphuric acid, and then through a drying chamber. Afterwards the strip is cooled in a blast of cold air, passes through the lacquering machine and then enters the lacquering stove. This has small dimensions and consists of two parts, one for drying and one for polymerization of the lacquer. For the lacquering of tinplate, f.i. in the Ballard oven, it is customary to use a stoving schedule of 190 - 200°C for about 20 minutes, but in the N.A.I. oven the total time for drying and polymerization is below one minute. It is consequently necessary to use a much higher temperature than usual to get a satisfactory film. After the lacquering process the strip is cut along the stitches, and the resulting individual strips are being coiled.

The plant now in operation is a pilot plant, for a width of strip of about 250 mm. A similar and bigger plant is now being erected and will be finished in the near future. It is constructed for strips being about 550 mm wide.

The lacquers employed are of the synthetic kind. For the time being mostly the Murphy lacquer 1457 from Interchemical Corporation, U.S.A. is being used, but a lot of others have also been tried. To get the best results with the above mentioned lacquering technique it is very likely that new lacquers especially adapted to the purpose must be developed, and well known lacquer firms are now working on this problem.

1. Control

During production the strips are subjected to a rigid control. After the rolling the ends of the strips have to be cut off, because there will always be variations in the normal thickness near the ends. The strips are also inspected for common faults, such as inclusions of extraneous matter (fig. 2, 3, p.4), flaws owing to original faults in the slabs (fig. 4, p.4) gas bubbles in the metal, etc. and after anodizing there will now and then appear holes owing to sparks in the electrolytic bath (fig. 5, p.4). This difficulty does not exist any longer.

12 samples are tested every day regarding the properties of the lacquer coating. The film weight for the Murphy lacquer 1457 ought to be about 20 mg/100 cm^2. The weight is determined either by dissolving the metal in hydrochloric acid and weighing the remaining film, or easier by burning away the film at 400°C. The lacquer film is further studied by application of the Erichsen electrotest, and by boiling of Erichsen cups in a 1/2 % solution of tartaric acid.

Fig. 2

Fig. 3

Fig. 4

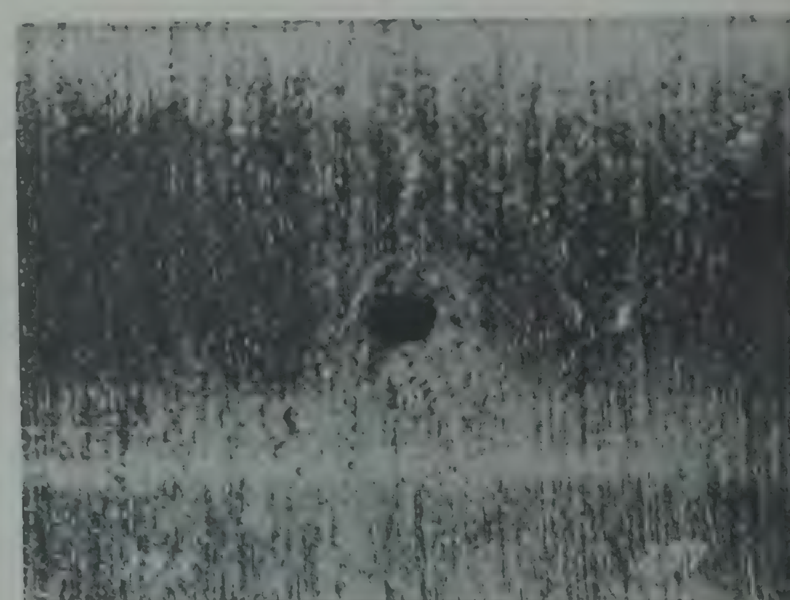

Fig. 5

III. MANUFACTURE OF THE CANS

As mentioned before the aluminium cans used in Norway are deepdrawn in one operation. Cans made by impact extrusion or by the Keller method are not described here, since we have no practical experience with such cans in Norway. The height of the Norwegian cans does not exceed half the diameter (for round cans). Both square, oval and round cans are employed; the common types are as follows (Table V).

TABLE V		
Type	Dimensions mm	Volume ml
1/4 Dingley ...	105 x 76 x 21.5	112
1/4 oblong	155 x 61 x 18	112
1/2 "	155 x 61 x 29.5	212
1/4 oval royan.	107 x 67 x 25	112
1/4 round crab.	78 x 32	115
1/3 round	101 x 42	300
1/2 round	108 x 54	450
1/1 round	137 x 68	900

All round cans are cylindrical, except the 1/1 can, which is conical. The empty cans can therefore be placed inside each other, thereby saving space during transport to the canneries. This is not so important for the smaller cans.

A spectacular feature of the aluminium cans is the corrugation, originally introduced to counteract physical swelling during processing. Now it is chiefly kept up to give the cans a characteristic appearance.

Before the cans are used for canning they ought to be controlled. The strain during the deepdrawing operation may result in the appearance of characteristic strain lines on the cans (fig. 6), but by faulty and careless work the strain can be too much, giving rise to cracks or holes (fig. 7). Similar

Cracks or holes can also be obtained due to metallic inclusions or gas bubbles in the metal. The holes almost always appear near the bottom of the can.

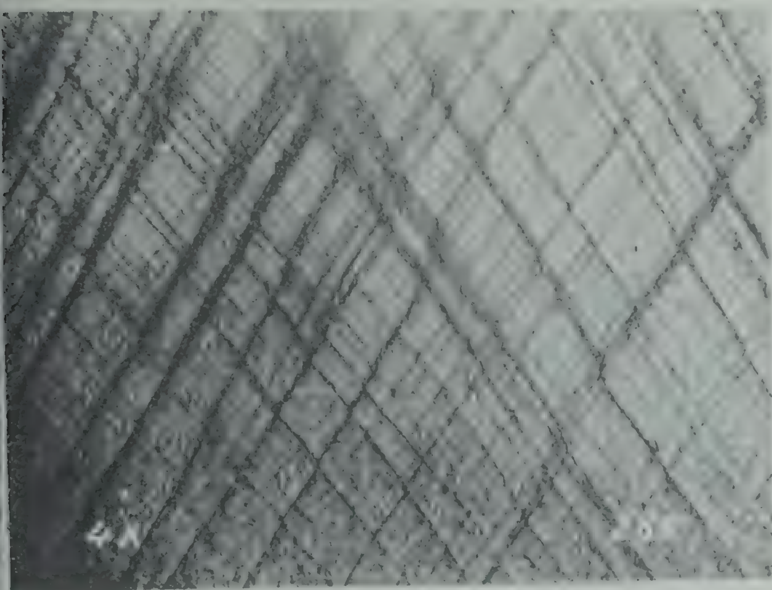

Fig. 6

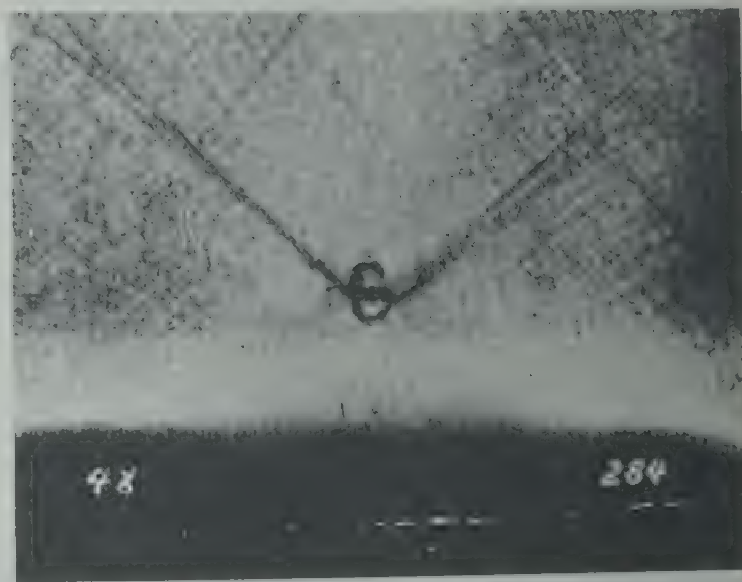

Fig. 7

IV. CANNING EXPERIMENTS

For more than 20 years, since the erection of the Research Laboratory of the Norwegian Canning Industry, there has been a close cooperation between this institute and N.A.I. concerning canning experiments with all types of aluminium cans. By mutual agreement no product has been recommended for packing in aluminium cans unless experimental packs, stored for a sufficient length of time at different temperatures, had been made.

I. Experiments with 2 S and 3 S

Up till now the general results of the storage experiments (based on 15°C) with 2S and 3S have been:

a) Fish products

Smoked brisling-sardines, smoked and unsmoked sild-sardines, mackerel fillets, small mackerel, tuna fish, all packed in edible oil (vegetable or marine origin), mackerel in jelly, fishballs in bouillon, fried fishcakes in gravy or bouillon, cod roe and cod liver can be safely packed in anodized 2S (later called Ex) with a shelf life of 2 years or more. Some of these products may also be packed in tomato sauce in lacquered Ex, but with varying results. Kippered herrings is the only product packed for sale in 3S, with excellent results. The shelf life is longer than that obtained for the same product in lacquered tinplate, owing to corrosion of the latter. Just like kippered herrings, soft herring roes have a tendency to pitting in Ex, but can be packed in 3S. This is however, not yet done on an industrial scale.

For some years it has been usual in Norway to make pastes from cod liver or from a mixture of cod liver and cod roe. These pastes have a high nutritive value, and are very rich in vitamins, especially A and D. They give, however, occasion to swelling and pitting in Ex, but can be canned in lacquered Ex.

b) Meat products

Pure meat and meat cakes in gravy ought to be packed in lacquered Ex. The reason for this is a special form of corrosion, the so-called fat corrosion, which will be described later on.

Also meat balls in bouillon ought to be packed in lacquered Ex on account of risk of swelling. The cause is the milk used for preparation of meat balls. If they are made with water, little or no corrosion takes place. The corrosive properties of milk are probably due to its content of citric acid. Like all organic hydroxyacids, citric acid has a pronounced corrosive action on aluminium.

c) Crustaceans

Shrimps packed in Ex give excellent results and can be stored for several years. To maintain the natural nice appearance of the shrimps for a long time, it is necessary to give them a pretreatment prior to

canning, to prevent the ugly bluish colouring normally developing in the flesh of canned shrimps on storage. The reason for the colouring is the wellknown fact, that the blood of crustaceans contains copper, which will combine with ammonia and amines to form blue complex copper compounds. Also mussels can be packed in Ex with a long shelf life, but natural and dressed crab or lobster must be packed in lacquered Ex on account of tendency to swelling. Regarding natural lobster there exists a special problem. This product causes a very strong, not yet explained pitting in Ex.

d) Milk

Sweetened condensed milk is, due to its high sugar contents, so little corrosive that it can even be packed in untreated 2S. Unsweetened evaporated milk, however, will soon swell even in Ex. In this case it is impossible to lacquer the cans, because milk is very sentitive to offtaste from the lacquer.

e) Vegetables

Peas and mushrooms can be packed and stored for years in Ex, but on the whole vegetables ought to be packed in lacquered Ex. Some vegetables, among them spinach, containing oxalic acid, will give trouble even then. The danger of corrosion can, however, be diminished by addition of calcium chloride or hydroxide, which will precipitate the oxalic acid as unsoluble calciumoxalate.

f) Fish delicatessen

Fish products, which are not sterile, but are preserved for a while by addition of salt, sugar, acid and sometimes chemical preservations, are very popular, especially in Scandinavia, but also in other countries. Such products ought not to be packed in aluminium, at least if we require a longer shelf life (at 10°C) than a month or two. Exceptions are some products packed in oil, f.i. smoked herring or salmon fillets, and the substitute for salmon (saithe).

g) Berries and fruits

Like all acid products berries and fruits ought not to be packed even in lacquered Ex. Some good results have been achieved with spray-lacquered cans, but as mentioned before, there is no interest for spray-lacquered cans in Norway.

In table VI the storage results of canned goods in aluminium cans are given in condensed form.

TABLE VI

3 S	2 S	Ex	Sheet laquered Ex	
Shelf life 2 / 3 years	Shelf life more than 2 years	Shelf life more than 2 years	Shelf life about 2 years	Shelf life varying
Herring soft roes Kippered herrings	Sweetened condensed milk	Cod liver Cod roe Fish balls in bouillon Fried fish cakes in bouillon Fried fish cakes in gravy Mackerel fillets in oil Mackerel fillets in jelly Mushrooms Mussels, natural Mussels, paste Peas Shrimps Small mackerel in oil Smoked brisling in oil Smoked sild in oil Tunafish in oil Unsmoked sild in oil	Asparagus Asparagus buds Beef Carrots Cauliflower Cod liver, paste Cod liver/cod roe paste Crab natural Crab dressed French beans Lobster natural Lobster dressed Meat balls in bouillon Friend meat cakes in gravy Parsnip String peas Wax beans	Borecole Caraway sprouts Celeriac Hamburg parsley Sild in tomato sauce Spinach Small mackerel in tomato sauce Smoked brisling in tomato sauce Tunafish in tomato sauce

2. Experiments with B 50 S

The canning experiments with B 50 S started about half a year ago, and a lot of systematic experimental packs have already been carried out. The tendency to corrosion has so far been small, but it must be remembered that only a short time has elapsed since the start of the experiments. It is therefore impossible today to draw any conclusions as to the properties of the new alloy, compared to those of 2S and 3S.

V. COMPARISON BETWEEN ALUMINIUM AND TINPLATE AS CAN MATERIAL

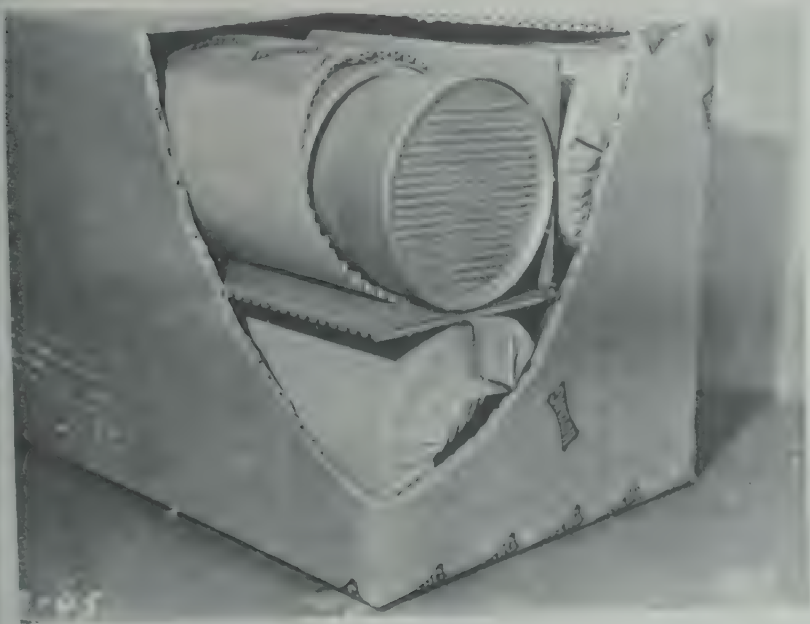

Fig. 8

On comparing tinplate and aluminium as can material, it cannot be denied that aluminium cans are mechanically weaker than tinplate cans, consequently requiring more careful handling during manufacture, and especially the big cans must be carefully wrapped for transport (fig. 8). Besides, aluminium is a little more expensive than tinplate. On the other hand, aluminium is lighter, has a more pleasing appearance, and the cans are easier to open than tinplate cans.

In the way of corrosion swelling occurs both in tinplate and aluminium cans with acid products. Alltogether aluminium tends more to swelling than tinplate.

Pitting is chiefly encountered in lacquered tinplate cans by packing of berries and fruits, but in aluminium pitting occurs in unlacquered Ex with salty fish products, containing trimethylamineoxide.

In two respects aluminium has distinct advantages as can material. In a corroded can the metal will dissolve in the contents. Dissolved aluminium salts are practically tasteless, even in appreciable amounts, but tin - and iron salts will give the contents a disagreable offtaste. In products producing volatile sulphides during sterilization and storage, such as shrimps or fishballs, no metal sulphides will be formed in an aluminium can, owing to the instability of aluminium sulphide, but in a tinplate can strongly coloured tin - and iron sulphides will develop, causing discoloration of the can and the product. Especially the black, loosely adhering iron sulphide is harmful, and this compound will be formed even in lacquered cans, in pores and scratches in the lacquer film.

On the other hand there are three forms of corrosion, which are specific to aluminium. They are:

1. Contact corrosion

Some years ago the canners now and then encountered the problem of the socalled contact corrosion. During filling the cans were placed on trays of tinplate, and if more cans were filled than could be seamed during the workday, the trays with the filled cans were stacked over night. The result was a severe pitting, due to formation of galvanic cells with the tray as cathode, the can as anode, and the content as electrolytic solution. To avoid this, aluminium trays are now commonly employed in the factories for aluminium cans.

2. Copper corrosion

This form of corrosion appears when aluminium cans come in contact with copper salts, introduced f.i. from coppercoloured vegetables, now prohibited in Norway and other countries, or from defective cooking utensils of tinned copper. The copper will be deposited on aluminium as metallic copper, forming local galvanic elements, and a strong corrosion will follow. The same phenomenon will of course also occur with other metals, nobler than aluminium.

3. Fat corrosion

The socalled fat corrosion of aluminium was discovered in the course of the last years. If meat products containing solid fat are packed in aluminium, the fat will melt during processing, then float upwards, and after cooling we get a solid layer of fat in contact with the inside surface of the can. In a short time we get a strong regional corrosion under the fat layer, with formation of hydrogen. It is not the fat which is corrosive; pure fat can be packed in aluminium cans without the slightest risk. It can be demonstrated that to get fat corrosion it is necessary to have a thin film of liquid between the fat and the metal. In that case it can be shown that there is a difference of potential between the covered and the uncovered part of the aluminium, the covered part forming the anode. The nature of the fat present is of no importance; the same kind of corrosion occurs even with paraffine wax. The fat corrosion is in accordance with Evans' differential aeration principle, but this principle is probably only part of the explanation. The problem has, however, not been theoretically studied yet. Either of the two last mentioned forms of corrosion can be avoided by suitable lacquering.

Altogether it seems that aluminium (2S, Ex, 3S) tends a little more to corrosion than tinplate, but

how this will be later on, it is difficult yo predict. That will depend on how the new alloy B 50 S turns out, and also on what quality of tinplates we will get in the future. The above mentioned comparison has been based on hot-dipped tinplate with a coating of at least 1.25 lbs/base box. Tin is, however, scarce, and the development goes in the direction of production of electrolytic tinplate with a reduced tin coating. This will in turn give rise to new corrosion problems, so that the comparison between the corrosive properties of aluminium and tinplate will probably soon have to be revised.

XLII. INTERNATIONAL STANDARDIZATION OF TINS FOR PROCESSED FOODSTUFFS

by G. WESTON

Technical Director of the British Standards Institution (United-Kingdom)

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I. IMPORTANCE OF FOOD CANNING

The importance of Food distribution has never been as widely recognized as it is to-day and it is hardly necessary to stress the significance of canning and its aid to equitable distribution.

Glut crops can be conserved and used in times of relative shortage; food can be held in store for long periods against an emergency; "seasonal" crops cans be spread over the whole 12 months of the year; "local" produce can be distributed throughout the world. Canned foods, therefore, constitute an important part of world commerce to-day.

It was in 1943 that the United Nations Conference on Food and Agriculture, meeting in Hot Springs, U.S.A., passed a resolution which included the following recommendation :

"that the permanent organization which they recommend .... should be set up ... and should inter alia "promote standardization of containers, both nationally and internationally ....."

In support of this recommendation, it was explained that :

"standardization of containers has not developed to the same extent as has standardization of grades. "Lack of standardization gives rise to waste and confusion in the distribution of food".

Technical Committee 52, Hermetically Sealed Metal Food Containers, of the International Organization for Standardization was set up to carry out this task and its work is not only of considerable importance but also of real urgency.

II. OBJECTIVES OF STANDARDIZATION

Standardization of cans whether effected in the national or international sphere should lead to economic benefits of no mean value.

It might be useful to reiterate some of the more outstanding of these benefits, and for convenience they might be considered in relation to the interests of :

1) the can manufasturer,
2) the canning industry,
3) the wholesaler and retailer,
4) the consumer.

I. The can manufacturer

Standardization for sizes leads to simplification, i.e. a reduction in the number of sizes of cans made. If the selection of sizes for this reduced range is efficiently carried out and a rational series of sizes is evolved, economy in the use of plate will be achieved. It was estimated that the simplification of sizes that was introduced in the United Kingdom during the war resulted in a saving of no less than 40,000 tons of tin-plate per annum, without inconvenience to the consumer.

The proportions and dimensions of the standardized sizes should be determined on a basis that provides maximum output for a minimum amount of plate. This having been done, the can manufacturer will be able to order tin-plate in a reduced number of sizes appropriate to the standard can dimensions, thus reducing his stock of plate to a minimum and still giving a reasonable "buffer"; incidentally, this also achieves economy at the plate mill. The present price of tin and the restricted supply of sheet steel make it more essential than ever that the most efficient use shall be made of such material as may be available and this consideration alone would more than justify pressing ahead to standardize sizes as rapidly as possible.

Simplification of sizes however brings many other direct and indirect advantages such as :

- longer runs with fewer changes on the production line, reducing spoilage and resulting in a better can;
- less capital invested in idle plant, tools and space;
- reduced tooling and set-up time;
- easier training of operatives;
- reduction of stocks of materials and components;
- simpler clerical and administrative work;
- easier service and maintenance;
- and, hence, increased productivity, leading to reduction in cost and prices and to increased sales.

A reduction in the number of sizes of tin-plate required by the can maker must lead to increased production from the tin-plate manufacturer, with particular reference to strip mill operations.

2. The canner

Standardization of cans is a first step to standardization of certain components of can-filling equipment, with resulting higher filling speeds, more accurate fill, and more efficient use of plant and labour. The number of different can ends to be stocked is restricted, simplifying storage, reducing storage space and "buffer" stocks. As it is not necessary to have available such a diversity of closing machine parts for a widely differing range of can sizes, a capital saving can also be achieved. The number of different sizes of labels required is also considerably reduced and labelling is simplified. The number of outer containers can similarly be reduced, there is thus the further saving in stocks, storage space, material and records for store-keeping.

3. The wholesaler and retailer

The wholesaler has to maintain sufficiently large stocks of all products in all sizes of cans to meet the varying demands of each retailer. A reduced range of can sizes for each product therefore simplifies his task - it decreases the amount of storage space he requires, lessens the capital tied up in stock and simplifies his record-keeping.

These advantages also apply to the retailer, but in addition, uniformity in can sizes for similar products makes it easier for him to arrange his display and general lay-out of goods - a factor of particular significance in "self - service" stores which are now becoming increasingly popular. He is able to concentrate his sales and advertising effort on a narrower range.

4. The consumer

In addition to the benefits which should flow to the consumer through the economies effected by the can manufacturer, the canner, the wholesaler and the distributor, standardization of sizes is of distinct advantage to the housewife. It is generally recognized that it is possible to adjust the dimension of cans so as to make a given volume appear larger than it is. Standardization of sizes ensures that " like can be compared with like ", a more equitable basis of purchase can be ensured and the possibility of the purchaser being misled can be avoided.

III. INTERNATIONAL STANDARDIZATION

The benefits enumerated above are not exhaustive but it is hoped that they are sufficient to show that standardization of can sizes is not merely desirable but essential - and essential equally to national and international trade.

The following considerations also add point to the necessity for international agreement on standards :

a) agreement on a standard range of sizes coupled whith an internationally recognized method of designating them will inevitably facilitate international trade, for by means of these designations, buyer and seller will be "speaking the same language";

b) several countries have statutory regulations or old-established trade customs as to the sizes of cans for foodstuffs, and it is often difficult, if not impossible, to export canned foods to

those countries in other sizes. International agreement on can sizes will obviate the necessity for separate production lines for home and export;

c) machines for making, filling and closing open-top cans are frequently imported from abroad, especially by the smaller European countries and this in itself justifies the use of common sizes in the countries exporting and importing the machinery.

It is with the object of achieving as many of these advantages as possible that a technical committee on hermetically sealed containers was set up under the International Organization for Standardization, and is applying itself energetically to the task of securing international agreement over as wide a field as practicable.

IV. THE INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

The object of the ISO is to promote the development of standards in the world with a view to facilitating international exchange of goods and services and to developing mutual co-operation in the sphere of intellectual, scientific, technological and economic activity.

As means to these ends, inter alia, it may :

a) take action to facilitate co-ordination and unification of national standards and issue necessary recommendations of member bodies for this purpose;

b) sept up international standards provided, in each case, no member body dissents;

c) encourage and facilitate, as occasion demands, the development of new standards having common requirements for use in the national or international sphere;

d) arrange for exchange of information regarding work of its member bodies and of its Technical Committees:

e) co-operate with other International Organizations interested in related matters, particularly by undertaking at their request, studies relating to standardization projects.

The operations of the ISO as it is generally called, are administered by a Council comprising an elected President and ten members, representing eleven countries in all, and the general affairs of the Organization are conducted by a General Secretary. The seat of the organization is in Geneva.

Any member body may suggest that a standardization project should be investigated on an international basis. When a proposal is receveid it is circulated to all member countries and they are invited to consider the matter. If the project is not specifically opposed by a majority of members and not less that five countries indicate their willingness to participate actively in discussion, the ISO Council approves the formation of a technical committee. The membership of the Technical Committee includes all member countries of ISO who indicate their wish to participate in the work of the Committee and the Secretariat is allotted by the Council to one of the member bodies. The Secretariat country collects and collates information from the participating countries, puts forward a suggestion for the scope of the work and prepares preliminary proposals for the consideration of member countries.

In the light of the comments and suggestions received, detailed proposals are drafted by the Secretariat : the exchange of views with member countries proceeds by post as long as possible and at an appropriate time a meeting is held which is attended by industries and other experts from the member countries.

The work proceeds on these lines until agreement has been reached when the decisions are submitted to all ISO members for consideration, the Technical Committee being responsible for examining all comments and suggestions received. Generally, the final decisions and recommendations are promulgated as national standards in each of the interested countries.

An "international standard" may, however, be issued if it is desired unanimously by the members of the Technical Committee and if no ISO member body objects.

Technical Committee ISO/TC/52, Hermetically Sealed Metal Food Containers, was one of the first committees appointed by ISO and the Secretariat was entrusted to the United Kingdom. The scope of the Committee's work has been defined as follows :

" To consider the standardization of hermetically sealed metal food containers, viz foodstuffs submitted to heat - processing <u>after</u> canning ".

In the first instance, the work is being confined to the development of :

a) a standard range of can sizes;

b) methods for the determination and expression of sizes;

c) nomenclature for sizes.

At a later stage, the Committee may recommend that the scope of the work be extended.

The countries participating actively in the work of this Committee are Australia, Belgium, Czechoslovakia, Denmark, France, Hungary, Italy, Netherlands, New Zealand, Norway, Poland, Portugal, South Africa, Sweden, Switzerland and the United Kingdom. The following have asked to be kept informed of the work : Austria, Brazil, Chile, China, India, Israel, Mexico, Roumania, USSR, Yugoslavia and Uraguay.

The Committee has held three meetings to date - in 1948, 1950 and the last in May 1951. At these meetings the foundation for the work of the Committee has been established and useful progress made in developing the programme. The following are some of the recommendations that have been agreed.

I. Metric dimensions

One of the first decisions taken - and one which has enabled the work to go forward - was that the metric system should be adopted for expressing the dimensions and capacities of tins.

2. Diameter range

Investigation has shown that there are considerable differences in the ranges of capacities and sizes of cans adopted in various countries : the aim of arriving at international agreement must therefore be a long term project. As a preliminary step, however, it has been agreed to recommend that individual can diameters falling within certain ranges should for purposes of international trade, be regarded as "commercially similar", i.e. although not truly standard, they fall within an agreed deviation. These groups of internal diameters with related capacities are :

Can N°	Diameter Range	Capacity Range	Can N°	Diameter Range	Capacity Range
1	148 - 156	4186 - 4314	6	69 - 75	412 - 438
2	148 - 156	3053 - 3147	7	62 - 68	306 - 325
3	97 - 103	837 - 863	8	52 - 58	205 - 218
4	80.5- 86.5	571 - 589	9	49 - 55	134 - 148
5	71.5- 77.5	451 - 479	10	49 - 55	66 - 74

This means for example that the French 1/1 can (100 mm. diameter and 850 ml. capacity) can be regarded as "commercially similar" to the UK and USA A2 1/2 can (99.47 mm. diameter, 848 ml. capacity).

Countries have been asked, so far as international trade is concerned, to concentrate demand as much as possible on can sizes which fall within these groups. If this proves possible, precise dimensional standardization of one can within each group may later prove a practical possibility although it is generally accepted that it will be sometime before this can be achieved. Already there is one can, however, for which agreement on precise dimensions may be possible in the not too distant future. This is the size known in many countries as A.2 having a diameter of 83.23 mm. As some countries are not yet manufacturing this size, it is not possible at this stage to discuss the details.

The recommendations so far made do not apply to cans as used for condensed milk but it is proposed that these shall be considered later, as will irregular drawn and built-up fish cans.

3. Capacity comparison

In order to ensure that cans are compared on an equitable basis, a method of determining capacity has been agreed for use with "commercially similar" cans. Briefly, this method involves weighing the empty can, filling it with water at 20° C and weighing the filled can. It is recognized that this method may not be sufficiently accurate when the precise dimensions of individual cans are considered and a more accurate method of determining can capacity may be sought.

4. Nomenclature

Another advance is that, while some countries will probably continue to use their own designations for cans in their domestic markets, it has been recommended that for international trade, round cans should be designated by their capacity in ml. and their internal diameter in mm. To take the example mentionned above, the French 1/1 can would be known internationally as "850/100".

5. Country of origin

In addition, it has been recommended that, the country in which the container is filler should be indicated and that for this purpose, cans shall be permanently and legibly marked (nor necessarily by embossing) with the abbreviations used internationally for motor car nationality plates. Such mark shall be conspicuous and shall be put on the can in a position where it is unlikely to be covered by a label.

Discussion has not yet taken place regarding rectangular cans and other irregular shapes, but it is proposed to consider these in due course.

The question of quality of material has also not yet been discussed but is has been suggested that the Committee should consider recommending preferential substances of tin-plate and that they should study the desiderata in regard to quality and tin coating.

The countries which are particularly interested in this subject have been asked to submit their views on these points and when agreement in reached, recommendations on the appropriate properties on tinplate for canning may be made to the ISO Technical Committee on Iron and Steel.

The ISO Technical Committee on Hermetically Sealed Cans for Processed Foods has maintained close liaison with the Cómité International Permanent de la Conserve and we hope that this valuable contact will continue. The activities of C.I.P.C. are much wider than that of ISO/TC/52 in that they cover all aspects of food canning but many of the problems they have under consideration affect or are affected by the cans used. Their work has thrown a spotlight on the need for can standardization, and as they have the opportunity of discussing all the related problems, many of the initial difficulties may by this means by cleared out of the way. They are therefore able to render considerable assistance to ISO/TC/52 by examining the problems of can standardization and preparing preliminary proposals to serve as a basis for international agreement.

In this way, international collaboration will be extended, the work of the ISO Committee furthered, and the achieving of world standards - the objective we all have before us - will be hastened.

XLIII. THE PERMANENT INTERNATIONAL COMMITTEE ON CANNED FOODS (C.I.P.C.) IN THE PAST, PRESENT AND FUTURE

by R. V. MANAUT
Chairman of C.I.P.C.

Ladies and Gentlemen,

Our programme now requires me to give you a talk on the Permanent International Committee on Canned Foods, the organisation which has brought you together for this 2nd International Congress on Canned Foods over which I have had the great honour of presiding.

But this audience is composed, on the one hand, of members who participated in the foundation of C.I.P.C. and who have taken part in its work for many years past, and, on the other hand, of many others who are not so familiar with C.I.P.C. So I must necessarily give the latter some essential information, sufficient to enlighten them, but not at such length as to discourage the former from giving me their attention.

It seemed to me that the best method would be, first of all, to make a few suppositions.

Imagine for a moment that C.I.P.C. did not exist (this is an assumption which will be acceptable for a few of you who are not very familiar with C.I.P.C., but against which those of you who are initiated will energetically protest).

Imagine also that this Congress is the first one which has brought you together, - an assumption which, after all, is again acceptable for those of you who did not attend the 1st Congress, but which is not acceptable to 1937 congress members, who, I know, have so vivid a recollection of the 1st International Congress on Canned Foods.

During these four days of work you have listened to eminent specialists, scientists, technologists, manufacturers, whom we can never adequately thank for their valuable co-operation. You have, of course, appreciated the high value of the papers which have been read. You have taken an active part in the discussions and endowed this Congress with its life and atmosphere. During these four days you have got to know one another and you have had interesting conversations of a professional order. You have, no doubt, touched lightly on matters of international interest. This being so, would you admit that an opportunity to meet one another, such as is offered you by this Congress, be quite exceptional and so short-lived as not to be repeated ? Surely not, and this 2nd Congress can but form a further stage in the fruitful co-operation established in 1937. To discuss on an international plane questions of interest to the various countries producing canned foods; endeavour to assist in the establishment of provisions for the removal of certain obstacles which, internationally, impede greater use of preserved foodstuffs by consumers; obtain information on everything that is being done in the world in connection with canned foods, whether it be in the field of science, technology or economics; exchange experiences and opinions; add up the capacities and working possibilities of each one of us for the benefit of all, - such is the object of C.I.P.C., and this is why I will say that C.I.P.C. is not only a useful, but an indispensable body.

So we are no longer dealing with suppositions, as it was on the basis of these considerations that the members of the 1st International Congress on Canned Foods agreed, in 1937, to follow up the event which had brought them together for so short a time.

To this end, on October 15, 1937 (we are almost celebrating an anniversary to-day), five resolutions were unanimously voted by the members of the 1st Congress. May I read them to you ? We would have hoped that the 1937 congress members would have amended them so as to make them shorter, if possible, as this would have enabled us not to take up your attention for so long a time.

The resolutions were as follows :

<u>1st resolution</u> : "The 1st International Congress on Canned Foods, after having taken cognisance of the proposal to institute a permanent international Bureau for Canned Foods, considering the benefits to be derived from such an institution by the world industry of manufacture and sale of canned foods, approves the principle thereof".

<u>2nd resolution</u> : "Considering that the decisions taken by the Permanent International Bureau for Canned Foods should have real possibilities of implementation, recommends that a national responsible organisation be created as soon as possible in each participating country".

<u>3rd resolution</u> : "As an initial implementation of the preceding resolution, the 1st International Congress decides to appoint immediately an Organising Committee for the Permanent International Bureau for Canned Foods".

<u>4th resolution</u> : "To facilitate the creation of the Organising Committee, the 1st International Congress on Canned Foods decides that the said Committee shall consist, at least temporarily, of the President of the delegation of each country represented at the 1st International Congress on Canned Foods, with, in addition, the Presidents of the principal associations which formed the Organising Committee of the 1st Congress".

<u>5th resolution</u> : "Considering that the French Interprofessional Committee on Canned Foods initiated the 1st International Congress and organised it, and that the discovery of the preservation of foodstuffs by

This being so, you will not be surprised that C.I.P.C. considers the National Canners Association as a kind of model, which there is no question of copying, but from which inspiration and, if possible, valuable advice can be obtained.

This is why we, in common with all members of C.I.P.C., are very desirous of having representatives of the National Canners Association attend our meetings regularly. The results that have been acquired by the many European missions which, under the aegis of the Marshall Plan, have had the opportunity of studying the American canning industry on the spot, would thus be most happily completed.

You now know what the membership of C.I.P.C. is; let me tell you in a few words what its methods of work are.

C.I.P.C., as I have already said, is still governed by the 1937 Agreement drawn up by its founders. It is composed of member - delegations which comprise the representatives appointed by the professional associations of the canning and allied industries in the respective countries. These delegations elect Officers - that is to say, a President, Vice-Presidents and a Treasurer. A Secretary General is in charge of dealing with all questions of an administrative order.

Up to the present, C.I.P.C. has held half-yearly meetings lasting on an average three days.

During these sessions, it first holds a plenary meeting for the purpose of becoming acquainted with the evolution of the questions dealt with in the interval between sessions and adopting a working agenda which is split up among specialised Committees. At the end of the session it holds another plenary meeting to hear the reports on the work of these specialised committees and, if necessary, to make recommendations.

Most of the questions which C.I.P.C. decide to study are investigated and prepared by specialised committees.

These are becoming more and more numerous as C.I.P.C. extends its activities; they organise their work themselves and examine the matters involved, with the assistance of Technical Advisors taken from the delegations.

When they deem it necessary, the committees may make proposals to C.I.P.C. at a plenary meeting; once these proposals have been adopted by a majority vote, they become recommendations which each member-délegation endeavours to have implemented in its own country.

The efficiency of C.I.P.C. is partly dependent on this implementation, which we consider of the greatest importance. We realise that it takes a long time, but this is the case with all international bodies, even governmental ones, and it is more especially the case with private international associations which, like C.I.P.C., have no connection in law with the governments of the countries represented, that is to say, with the authorities who are competent to decide on the application of recommendations such as those we issue.

We have endeavoured to accelerate the application of such recommendations and in so doing we have been led to establish close relations with certain official international bodies in charge of examining questions which C.I.P.C. is also trying to solve.

As an instance of these relations, we may mention those we have entered into with the International Organization for Standardization (I.S.O.) and with the Food and Agriculture Organization of the United Nations and this morning Mr. WESTON told you of all the benefits which can be mutually derived from co-operation of this kind, co-operation which, on our part, we shall always try to extend.

This, in brief, is the present position of C.I.P.C. which is both a gentlemen's club and an organisation with utilitarian aims.

I still have to say a few words concerning our future.

We have no claim to foretell the future of C.I.P.C.; but we shall merely try to work out, on the basis of the present situation, what are the main principles which should govern the outcome of this institution to which we are so deeply devoted.

As to our working methods, all members of C.I.P.C. are agreed that they should be still more efficient so as to permit of attaining result more quickly.

This is why we have already decided to eliminate from our plenary meeting the discussion of all questions requiring to be thoroughly studied and which, consequently, can only be dealt with after they have been studied in great detail by a limited number of particularly competent technicians representing each country concerned.

Consequently, we must henceforth give as much importance as possible to our specialised committees.

As to implementation of C.I.P.C. recommendations, every possible effort must be made. You know that one of the first preoccupations of C.I.P.C. was directed to obtaining in all countries unity among the professional organisations concerned with the canning industry. This desire was the main reason for the second resolution providing for the institution of C.I.P.C. which I read at the beginning of this talk. And by "unity" we do not mean physical unity, but a unity of views, a unity of action with regard to the questions dealt with by C.I.P.C.

The common task on which the members of C.I.P.C. have set their minds is to see the Committee recognised in all the countries represented on it as an advisory body whose recommendations would always be taken into consideration, or whose advice would be taken whenever the authorities had to make a decision concerning the canning industry. Yes, we may well see, at some time in the future, such a governmental body enquiring as to what C.I.P.C. "thinks" before coming to a decision. Moreover, this has already happened in France in connection with canned fish, and we should like to have it generalised. What better way could there be of succeeding than giving C.I.P.C. sufficient authority, that is, one more, increasing its representative character ?.

As to the questions of which the study will form the basic activity of C.I.P.C., we may say that as far as some of our present work is concerned, and although one stage has been completed, many long sessions will still be needed before it can be concluded. As to questions which are not yet being examined, what can I say ? The members of C.I.P.C. will be the sole judges when the proper time comes; their President must in

no way influence their decision, but he will always see to it that the programme they will have drawn up in common is carried out.

During the working sessions of the Congress, our members will certainly have given thought to questions which could be proposed to, and adopted to advantage by C.I.P.C. at its meeting to morrow.

Furthermore, we hope that representatives who are not yet members of C.I.P.C. will attend this meeting; we ask them not to hesitate to let us have their opinion and to help C.I.P.C. to reach one of its aims, - an increased consumption of canned foods.

We will conclude by expressing the foregoing wish. Mr. Henri CHEFTEL, Chairman of the C.I.P.C. Scientific Committee, and Mr. Pierre PEISSI, Secretary General, will now speak to you concerning our Committee's work. We will give them the floor.

XLIV. REPORT ON THE SCIENTIFIC AND TECHNICAL WORK OF C.I.P.C.

by H. CHEFTEL
Chairman of the C.I.P.C. Scientific Committee

Study of problems more especially of a scientific and technical nature was entrusted to a committee of specialists, each delegation representing a member-country of C.I.P.C. comprising, insofar as possible, at least one expert with scientific qualifications.

The first question which the Scientific and Technical Committee had to examine was the choice of subjects to be brought to the attention of C.I.P.C. The thorough knowledge which most members of the Scientific Committee have of current problems in laboratories specialised in the study of canned foods caused the immediate elimination of two subjects which non-specialists would, on the contrary, have been tempted to retain and which are still dealt with too frequently in a general form of no interest to any well-informed technician, i.e., the nutritional value of canned foods and their sterilization. This situation has of course changed since 1937.

With regard to the nutritional value of canned foods, general periodicals and analyses of existing data were available in sufficient numbers, the very first of these being that by E.F. KOHMAN (1), who had made a remarkable contribution to the subject by his experiments. These studies, however, had been superseded by the most recent knowledge acquired in the field of vitamins (isolation and synthesis of several vitamins, distinguishing the various factors of group B, new dosage methods for amino-acids and in connection with certain states of nutritional equilibrium). One report more would have been of no use; what was needed was extensive experimental work, taking up the whole question again in the light of the new data available. But the newly instituted Scientific Committee had neither the authority nor the means for undertaking such a task and, on the other hand, it was a well known fact that a plan of this kind was already under consideration in the United States. The food problems raised by the war were to hasten its execution and as early as 1942 a programme subsidised by the National Canners Association and the Can Manufacturers' Institute was worked out (2).

A first part of this research related to the proportions of carbohydrates, fats, proteins, calcium, phosphorus and iron, and of six vitamins (ascorbic acid, carotene, thiamine, riboflavin , niacin, pantothenic acid) in about forty canned foods of commercial quality, and was carried out on samples collected in different seasons and in various parts of the United States. Almost a thousand average samples were examined, and the results of these studies were incorporated, in the form of tables and diagrams, in a booklet published by the Can Manufacturers' Institute (3). The original reports were published in "Food Research" (1946), "Journal of Nutrition" (1944) and "American Journal of Dietetic Association" (1945 and 1947). Many United States Universities and scientists co-operated in this work. The analyses, made on canned foods such as they are found on the market, covered the amino acids content of three types of canned meat and five of canned fish, in particular their content of the ten indispensable amino acids (4).

A second part of the programme covered the study of the various processing operations (including harvesting, transportation and warehousing of raw materials, and warehousing of finished products) from the point of view of their effects on the nutritional value of the product; then, a search for means of improving any of such operations which might be found unsatisfactory. Most of the reports published under the Nutrition Program deal with this aspect of the question. Special attention was paid to the blanching of vegetables, this process having been found to be particularly harmful in certain cases. Research was also made in co-operation with manufacturers of equipment. In fact, this is the work on which Messrs. KING and CLIFCORN have spoken to us.

As to sterilization of canned foods, it is sufficient to mention the work of C.O. BALL and the different reports published since then, to show that in this matter also, our United States colleagues have contributed a vast theoretical and experimental documentation to the food-canning industry.

The reason why we have referred at such length to the research which has been, and is being carried out by the United States is to explain why, in establishing its program of work, the C.I.P.C. Scientific and Technical Committee directed its attention to other subjects.

As to problems of a bacteriological order, the Committee considered that the bacteriology of canned foods, whose preservation does not depend on complete sterilization, was not sufficiently known. This opinion was confirmed by an interesting report which C.P. STUMBO, a former associate of C.O. BALL and, later, Director of the Food Machinery Corporation's Bacteriological Laboratory, kindly prepared in order to assist C.I.P.C. in drawing up a plan for research work. Products of the kind mentioned above, comprise, for instance, canned ham, certain other meats, foie gras, various semi-sterilized fish.

This is an extensive problem which may require several years' experimental studies. Consequently, in the light of the different suggestions made as well as of the practical possibilities, the Scientific Committee proposed that each delegation should, in its own country, wherever a laboratory specialized in the study of processed foods exists, cause research to be undertaken on the microbial flora of cans, both normal and damaged, for a typical product of the kind concerned.

We were thus able to collect very instructive data concerning the bacteriology of anchovies and of foie gras. However, certainly by reason of the very considerable research work to be done and the difficulty

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NOTA : Figures between ( ) refer to the Bibliography, p. XLIV - 3.

of detaching the qualified staff for carrying it out, we were unable to obtain the assistance we needed for studying the bacteriology of processed tomato purée, rollmops, red herrings and canned luncheon meat also, as we had intended to do before this Congress.

To offset this, may me say, the Congress had the benefit of the interesting papers prepared by Miss V. ASCHEHOUG, Chief of the Department of Bacteriology, Norwegian Canning Industry Laboratory, and by R. BUTTIAUX, of the Pasteur Institute in Lille, on Norwegian semi-sterilized fish and the bacteriological examination of canned ham, respectively.

As to the nutritive value of processed foods, one point which has been given but little attention was their digestibility proper. Precise information on this point is, however, very useful, either for making known the dietetic and clinical value of certain canned foods, or for revealing possible defects and enabling them to be remedied.

Thanks to the help given us by distinguished French physiologists, we were able to draw up a programme of experiments in this connection.

Two simultaneous methods of study were laid down: on the one hand, "in vitro" attack by the pepsin pancreatin mixture, and study of the speed of hydrolysis of the lipids, proteins and carbohydrates contained in various standard foods, either raw, cooked by home methods, or canned; and on the other hand, a similar study carried out "in vivo" on laboratory animals.

M. FONTAINE, Professor of Physiology at the Natural History Museum (France), and one of his lady assistants kindly co-operated with us in the execution of this programme. The result of his work on the digestibility in vitro of the proteins contained in beef, pork, tunny and sardines, and in peas and beans, was shown in a report submitted to the Congress.

The Scientific Committee also made a study of two questions of more immediate practical interest, - legislation dealing with processed foods, and methods of analysis applied to inspection and control of such foods.

The ultimate purpose of these investigations is to work out the bases of possible unification and thereby to promote international trade.

Our original aim was :

- to assemble as complete a documentation as possible on these two subjects;
- to sort out this documentation and make it available to the industries concerned;
- to emphasize similarities, on the one hand, and contradictions, on the other hand;
- to examine the means of eliminating or attenuating the latter.

But later on it was found very difficult in practice to collect and keep up to date complete documentation relating both to legislation and to methods of analysis, especially with regard to the former, on account of the dissemination of the various texts of law or regulations. Moreover, owing to the great diversity of both form and substance of the texts we were able to obtain, this work would have taken an extremely long time and would possibly have been irksome.

We therefore altered our original plans.

As far as legislation is concerned, C.I.P.C. is above all endeavouring to draw up definitions of processed foods which occupy an important place in international trade; in doing this, it is, of course, taking into account the evolution of regulations applicable to canned foods on the international plane.

Several committees have been put in charge of this work. For the time being, it covers canned tomatoes, peas, apricots, and fish, but it will be extended in the future. We may mention that, as regards canned fish, one of the aims of C.I.P.C. is to standardise the common names of certain species of fishes, more especially clupea and tunnies.

Our first studies on analytical methods dealt with the determination of the titrable acidity and the volatile acidity, total nitrogen and the crude fat; a method was adopted for the determination of acidity. Later on, methods of determining total solids, chlorides, and sugars were studied; and more recently the determination of the copper, lead, tin and sand content was added to our programme.

The C.I.P.C. Scientific and Technical Committee devoted a large part of its last meetings to these studies and adopted the following procedure for its work in this field.

For the study of each method of analysis :

1) as a starting basis take the A.O.A.C. method (Association of Official Agricultural Chemists), subject it to critical examination and experimentation;
2) complete this starting basis by an examination of the information sent in by the competent members of each delegation concerning the principal methods in use in their respective countries;
3) suggest a method;
4) proceed to compare this method with those is use in different countries;
5) study the comments suggested by comparative experiments.

Here we must observe that the C.I.P.C. Scientific Committee has no intention of suggesting that the methods it may recommend should be compulsorily used; they are merely intended to serve as standard methods when comparisons have to be made or when disputes arise in the canned food trade.

The C.I.P.C. Scientific and Technical Committee also gave its attention to other questions; among these were the methods for examining empty cans and the marking of cans; also, recent technical progress made in the canning industry.

This last question had been considered as soon as our work was resumed in October 1946. It was all the more imperative because of the great progress made in theory and practice during the war. However, as we expected to give it an important place in the programme of the 2nd International Congress on Canned Foods,

we deferred studying it until the date of the Congress had been fixed, so as to be able at that time to submit reports which would be as up-to-date as practicable, and further, so that we might have as many chances as possible of obtaining the indispendable collaboration of the most eminent specialists in the principal countries producing canned foods which are not represented on the C.I.P.C.

As you know, we were able to carry out our plan thanks to the kind help given us. We believe the Congress will thus have had a full and precise idea of the technical progress made in the canning industry throughout the world during the last 12 years.

In describing the work done by the C.I.P.C. Scientific and Technical Committee we do not claim to have accomplished any incomparable achievements. We even regret not having been able to present concrete results to the Congress, as we had hoped, in particular with regard to legislation and methods of analysis.

One of the purposes of this Assembly is to judge our work and direct it; we shall be glad to hear its remarks on what we have accomplished and its suggestions for our future activity.

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XLV. REPORT ON THE WORK OF C. I. P. C. IN THE ECONOMIC FIELD

by P. PEISSI
Secretary-General of C. I. P. C.

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The purpose of the C.I.P.C. in the economic field is to increase the consumption of canned foods, in particular by means of a co-ordination of the laws and regulations governing preserved foods in the various countries. Up to the present the C.I.P.C. had directed its activity towards standardising the dimensions of empty cans and the inscriptions to be placed on filled cans.

Our report will therefore deal with the work accomplished by the C.I.P.C. on these two questions and the results attained by it.

However, it will be concluded by a few words concerning the efforts made by the C.I.P.C. to collect figures permitting world statistics to be kept with regard to production, importation and exportation of canned foods and we shall refer to the main points of the relations which the C.I.P.C. maintains with certain official international bodies and certain professional associations in countries which are not so far represented on our Committee.

In the early days following revival of its work, in October 1946, the C.I.P.C. reviewed the documentation it had collected and the relations it had established before the war in connection with standardization of cans and inscriptions to be placed on them.

By examining these two questions jointly, we were able to submit a "5th Report on Inscriptions to be placed on cans and on Standardization of round cans", to the 1st semi-annual meeting of 1948. As requested, we included in this report the first concrete proposals which the C.I.P.C. has received on this subject.

To allow a more thorough study to be made, the two subjects, - standardization and inscriptions,- were separated. Later on, for the same reason, the study of each of them was divided and even sub-divided.

One special aspect of the second subject, the technique of marking cans, was referred for consultation to the Scientific Committee and, more particularly, to Mr. HUNTLEY (United Kingdom), who drew up a report which he submitted to the 1st half-yearly meeting of 1949.

I. STANDARDIZATION OF ROUND CANS FOR PROCESSED VEGETABLES AND FRUITS

We shall not deal here with a history of the work accomplished by the C.I.P.C. and its constant progress thanks to the specialised Committee of which Mr. V.J. DRESCHFELD (United Kingdom) is the Chairman; we shall merely state the final results obtained by the C.I.P.C.

After difficult preparatory work, which may have seemed to last a long time, in the first half of 1949 the C.I.P.C. began to make definite recommendations to the International Organization for Standardization (ISO) in view of international standardization of certain round cans.

Up to the present, the C.I.P.C. has recommended 13 round cans, which ISO, during its last meeting in Paris, in May 1951, decided to adopt for international standardization.

The significance and importance of this result should be noted, for it shows that, as far as questions which it has the means and time to study are concerned, the C.I.P.C. is able to give useful co-operation to official international bodies dealing with such matters, without its action being considered as meddlesome and vexatious.

And yet, it proved difficult for C.I.P.C. to obtain recognition on the part of ISO.

In pre-war days, international standardization was dealt with by the League of Nations. The United Nations Organization which can be said to have replaced the League took over this question. On October 24, 1946, at a conference held in London, an international standardization organisation was instituted to take the place of the United Nations Committee on co-ordination of standards which had been set up provisionally.

As soon as it had been created, ISO drew up a list of subjects to be studied, classifying them in order of urgency and deciding which country should assume the secretariat for each subject. First on the list was standardization of sizes of metal containers for preserved foods and the British Standards Institution (B.S.I.) was designated to assume its secretariat.

On being informed by B.S.I. of the activities of C.I.P.C., the United Nations Committee on co-ordination of Standards wrote to C.I.P.C., asking it not to undertake any work which might duplicate that of ISO.

In July 1947, we had an interview in London with the temporary General Secretary of ISO who, on being informed of what the C.I.P.C. really was, suggested that it might co-operate with ISO by attending its meetings.

At that time we also established contact with B.S.I.

But shortly after our return to Paris, ISO was finally constituted and we were informed by the Director of B.S.I. that only indirect aid could be given ISO by the C.I.P.C. This would consist of sending ISO, through the latter's national Member Committees of countries represented on C.I.P.C., such information as C.I.P.C. considered useful to transmit.

Anyhow, we applied ourselves to keeping in touch with B.S.I. During trips to London we made them several visits which, we take pleasure in saying, were facilitated by C.I.P.C. member - delegations of the United Kingdom and the International Tin Research and Development Council, in particular, Mr. DRESCHFELD and Mr. LEWIS. We constantly kept B.S.I. directly informed of decisions taken by C.I.P.C. Finally, we were allowed to attend, as observers, the meetings of the ISO committee specialised in the study of standardization of cans, i.e. Technical Committee 52, Hermetically sealed metal food containers, which were held in London (October 1948 and May 1950) and in Paris (May 1951). So, from October 1949, direct co-operation was established between ISO and C.I.P.C.

The result of this co-operation is that up to now ISO has adopted for international standardization, only cans, and all the cans (round) proposed by C.I.P.C. Furthermore, as far as inscriptions on cans are concerned, here again ISO has adopted the recommendations made by C.I.P.C. It is sufficient to read the minutes of ISO meetings to see how frequently the work and decisions of C.I.P.C. were referred to during the said meetings.

II. STANDARDIZATION OF CONTAINERS FOR PROCESSED FISH

Here again, we shall not give a history of the work done by the specialised Committee which was first presided over by Mr. de CLERVILLE and later by Mr. JONCHERAY. We shall confine ourself to saying that standardization of containers for canned fish did not advance as quickly as that of round cans (for canned vegetables and fruit), on account of the many types of cans, the different shapes in use for each type of can, etc... and also because after the war work on this subject was not resumed until the first half-yearly meeting of 1948.

However, in this field also the work done by C.I.P.C. was found useful, as ISO has decided to postpone the study of canned fish containers until C.I.P.C. has informed it of the result of its work.

III. INSCRIPTIONS TO BE SHOWN ON CONTAINERS

Our 5th report on the inscriptions to be placed on cans and standardization of round cans was examined by C.I.P.C. at its 1st and 2nd semi-annual meetings of 1948.

This report was subdivided as follows :

1. inscriptions to be put in indelible type on the metal of the container : country of production, manufacturer's symbol, year of manufacture; and
2. inscriptions to be placed on the label or on the illustration printed on the can: composition of essential items, i.e., usual name of principal product and of each of the principal ingredients.

To enable the problem of description of the contents to be solved, a programme of work was established, with the object of settling the names, in the various languages, of the same principal products and ingredients. This work was to deal with all agricultural products, tomato purees, mushrooms, peas, fruit, unsweetened or in syrup, fruit juice; for fish, clupeidae and tunnies, and the oils used for their preparation.

The work was undertaken, tables were made out, reports drawn up (in particular, concerning the appellations of fishes), but the problem was found to be far more complicated than many had thought it was; in fact, it involves the regulations covering products (standards) with which it is now bound up in the work done by C.I.P.C.

Nevertheless, the problem of the appellation of fishes and preserved fish was given for a long time, and is still being given attention by C.I.P.C.

This problem is an important one. F.A.O. has just made a thorough study of the question, limiting itself, however, to the scientific and usual appellations of fish, without trying to establish commercial appellations either for the fish itself or for the foods prepared from it.

On the other hand, as ISO has included in its work the matter of the marking of cans, C.I.P.C. informed it of the recommendations it had made on the subject. C.I.P.C. can feel gratified that certain of its recommendations have been taken over and adopted by ISO, for instance, the one concerning the indication of the country of origin by means of symbols.

IV. STATISTICS

At its first half-yearly meeting of 1947, on motion of the Swiss member-delegation, C.I.P.C. decided to keep world statistics of the finished products of the principal kinds of canned foods.

At the following meeting, as Rapporteur on this new subject, we suggested that before the end of the first quarter of each year, each member - delegation of C.I.P.C. should send the Secretariat the production figures (in weight) for its own country of each kind of canned foods for the whole of the preceding year, using a given nomenclature which, however, would not be restrictive. The production figures reported should, as regards round cans, be split up into three categories according to the capacity of the containers.

We also proposed that at the same date and in a similar way each member-delegation should send the Secretariat its country's import and export figures for the same types of canned foods.

The C.I.P.C. having agreed to these proposals, we drew up a detailed questionnaire which was forwarded to the different member-delegations. Many of them did not send in any figures, or only supplied incomplete data. As a result, the statistical tables showing the various products which the Secretariat drew up for the years 1947 and 1948 presented many gaps.

In view of the persistence of the difficulties encountered in this filed, during the 2nd half-yearly session of 1949, it was decided that the problems involved in the statistics to be kept by C.I.P.C. would be reconsidered. We then prepared a report on the keeping of statistics by C.I.P.C. which was submitted to the first half-yearly meeting of 1950. A special Committee under the chairmanship of Mr. LEWIS (International Tin Research and Development Council) was instituted to examine this report. At the present time the work of the Committee is under way but, pending its conclusion, C.I.P.C. has had to give up keeping statistics for the time being.

We have made a brief review of the principal subjects of work of C.I.P.C. in the economic field and given a general idea of the results attained. We will now refer to the relations which C.I.P.C. has established and maintains with official international bodies other than the one already mentioned (ISO), and with professional associations in countries which are not yet represented on the C.I.P.C.

V. RELATIONS MAINTAINED BY C. I. P. C. WITH CERTAIN OFFICIAL INTERNATIONAL ORGANIZATIONS OR CERTAIN INDUSTRIAL ASSOCIATIONS IN COUNTRIES WHICH ARE NOT YET REPRESENTED ON IT

You know that in October 1945 the Food and Agriculture Organization of the United Nations, known as F.A.O., was instituted at Quebec. You also know that the action of F.A.O. extends at one and the same time to agriculture, sylviculture, fisheries and food and that its origin can be traced back to the work carried out in common between the two world wars by the Nutrition Section of the League of Nations, the International Labour Office and the International Institute of Agriculture, as well as to the activity of the International Centre for Sylviculture.

The C.I.P.C. decided to make contacts with the F.A.O. as early as April 1947 at its 2nd post-war half-yearly meeting and the Secretary General was put in charge of implementing such decision.

Thanks to the kind intervention of Mr. W.R. LEWIS (International Tin Research and Development Council) with Sir John BOYD ORR, then Director of F.A.O., we entered into relations with representatives of the latter organisation, i.e., the Manager of the Nutrition Division, on the occasion of an F.A.O. Conference held in Geneva in August/September 1947. At that time, the question of co-operating with C.I.P.C. was discussed.

F.A.O. could not allow C.I.P.C. to take part in its meetings as these can only be attended by representatives of the Governments of the various member-countries. However, we organised an exchange of documents between F.A.O. and C.I.P.C. and we suggested that C.I.P.C. might make certain studies which would enlighten F.A.O. on the question of preserved foods.

During the second semi-annual meeting of 1947, we suggested that C.I.P.C. should study one or more questions likely to be of interest to F.A.O. C.I.P.C. chose the question of the production capacity of canning factories and their supply of fresh products, tinplate and cans, because of its importance in the rational use of world food ressources.

Subsequently, F.A.O. recognised the importance of this question and also asked C.I.P.C. to help it with regard to the following matters :

- creation of a scientific review dealing with questions of preserved foods, in particular their nutritional value;
- documentation concerning the laws governing the wording of inscriptions placed on preserved food containers in the various countries;
- documentation concerning the laws providing for the control of food (including canned foods) in the various countries.

We also obtained that F.A.O. would send representatives to C.I.P.C. congresses.

Already in 1949 a representative of F.A.O. attended the second C.I.P.C. half-yearly meeting.

May I say that it did not prove easy to improve our relations with F.A.O. as until quite recently the seat of this organisation was in Washington and we were unable to have any personal contact with the officers apart from that we had in Geneva in 1947. But it is most likely that the presence of Messrs. Van VEEN and Mogens JUL, F.A.O. representatives, at the 2nd Congress will have a favourable influence on these relations which should also be facilitated by the transfer of F.A.O. to Rome.

Furthermore, C.I.P.C. has also maintained relations with the International Tin Study Group with respect to the keeping of statistics.

With regard to relations with industrial associations in countries not yet represented on C.I.P.C., we shall not refer to those established some time ago with associations of canners in the United Kingdom and Sweden, as they have resulted in these countries now being represented by a delegation to C.I.P.C.

Let us hope that those we maintain with Canada, South Africa, Australia, India, Israël, Finland, Egypt, the United States and former members of our Committee from whom we were cut off by the war, will have the same fortunate consequence.

As far as the United States is concerned, we think it is of interest to remind our members that a first contact had been established by us with the National Canners Association in 1937, on the occasion of a trip to the United States. Subsequently, minutes of C.I.P.C. meetings were regularly transmitted to the National Canners Association. Personal relations were resumed in 1949 by Mr. WITTOUCK (Belgium) and in 1951 by Mr. FREREJEAN (former secretary of C.I.P.C.). In addition, Mr. CADBURY (United Kingdom) has been good enough to endeavour to bring the United States into C.I.P.C. by writing a large number of letters to outstanding members of the canning world of that country.

SUMMARY OF DISCUSSIONS

For greater convenience and clarity, the discussions which took place during the meetings of the Congress are reported for each meeting, not in chronological order, but according to subject-matter.

FIRST MEETING
(Tuesday, October 16 - afternoon)

This meeting, presided over by Professor Ch. RICHET, Member of Académie nationale de Médecine (France), was devoted to questions connected with nutrition.

Papers I, II and III on the program were submitted.

None of them gave rise to any technical discussion.

SECOND AND THIRD MEETINGS
(Wednesday, October 17)

AGENDA : Technical progress achieved by the canned food industries in various countries since the 1st International Congress on Canned Foods was held (October 1937).

CHAIRMAN : H. CHEFTEL, Directeur, Laboratoire de Recherches, Etablissements J.J. Carnaud et Forges de Basse-Indre (France).

REPORTS SUBMITTED

The agenda of the second and third meetings provided for the submission and discussion of two series of reports on the technical progress in the canned food industry since the 1st International Congress on Canned Foods was held, one of these being reports drawn up per country (VIII to XXV), the other, general reports by type of product (IV to IX) bringing out the most remarkable technical developments which had taken place throughout the world in the various branches of the canning industry.

At the suggestion of the Chairman, it was decided that only the four reports and reports XIII and XIV on technical progress made in the United States would be submitted at the meetings.

The order of submission of the said reports was fixed as follows :

2nd meeting - Wednesday, October 17, morning.

1. Technological advancement in food processing methods in the canning industry in the United States, report XIII, submitted by the author, C.O. BALL - Research Specialist in Food Technology, Rutgers University (United States).

2. Twelve years' progress in the canning of fishery products, report IV, submitted by the author, M. JUL, Chief of the Technology Branch, Fisheries Division, Food and Agriculture Organization of the United Nations.

3. Technical progress in the canned meat industry, report V, submitted by the author, J.P.K. van der STEUR, Chemical Department, Lever Brothers and Unilever (Netherlands).

3rd meeting - Wednesday, October 17, afternoon.

1. Twelve years' progress in the United States canning industry, report XIV, by R.H. LUECK, General Manager of Research, American Can Company, and K.W. BRIGHTON, Supervisor, Technical Laboratory, American Can Company (United States). American Can Company, submitted by Berton S. CLARK, Vice-President, American Can Company.

2. Development in fruit canning, report VII, submitted by the author, W.B. ADAM, Deputy Director, Fruit and Vegetable Preservation Research Station, University of Bristol (United-Kingdom).

3. Technical progress in the vegetable canning industry throughout the world during the last ten years, report VI, by J. DUROCHER, Directeur, and G. ROSKIS, Chef du Service de Documentation, Institut national de la Conserve (France), submitted by the first-named.

SUMMARY OF DISCUSSION

The discussions which took place after each series of reports dealt with the following questions :

a) fishery products;
b) sterilization processes;
c) canned vegetables, Blair process (page 3);
d) canned fruit (and vegetables) - ascorbic acid (page 3);
e) canned fruit - vacuum syruping and sealing (page 4);
f) fruit preserves - copper and stainless steel equipment (page 5);
g) miscellaneous questions - bacteriological aspects (page 5).

a. Fishery products

Taking up certain questions raised in Mr. JUL's report, Mr. CHEFTEL, Chairman, asked Mr. CARVALLO (France) whether the continuous autoclave designed by him (P.C.100) also enables non-cylindrical cans to be processed.

Mr. CARVALLO explained that, thanks to the principle of the tubular basket used in his apparatus, it is possible to use the latter to process any container, whatever its shape or character, which can be placed in the basket. So far the industrial plants in use have only processed round cans, but there is absolutely no obstacle to treating cans of a different shape. Moreover, it is planned to use the " Carvallo " sterilizer-cooler in the near future for processing canned fish. The only difficulty which arises in this connection is the automatic placing of the cans in the tubular baskets, but this is a purely mechanical problem.

As a matter of fact, tests have been made with parallelopipedal metal containers filled with fish and glass containers filled with vegetables. The range of temperatures of the most recent type P.C. 100 autoclaves is such as to permit of processing glass containers easily. In the latest apparatus made it was found possible to sterilize vegetables in glass jars at the rate of 165 containers a minute.

Mr. CHEFTEL asked Mr. NAVARRE (Etablissements Frédéric FOUCHE, France) to answer another question raised in Mr. JUL's report relating to the results achieved with the "Toquer" fish processing line and, in particular, whether its mechanical device for sardine heading and eviscerating is already in industrial operation.

Mr. NAVARRE stated that the tunnel section of the "Toquer" apparatus is in use in two French factories, but the heading part is still in the experimental stage.

At Mr. CHEFTEL's request, Mr. MEESEMAECKER (Directeur Technique des Laboratoires, Fédération des Industries de la Conserve au Maroc) gave some setails with regard to the " Bonnefon " apparatus, which was tested in Morocco as far back as December 1950. The principle of this apparatus is similar to that of the I.M.C. and Mather & Platt equipment, since it is also designed to cook the fish after it has been canned in the raw state. Although it is still difficult at this time to form an opinion of its exact utility, the " Bonnefon " apparatus has the advantage of not requiring much space and of permitting of the production of approximately twenty cases (2000 cans) an hour. On the other hand, its comparatively low cost enables a large number to be used in big factories.

In order to emphasize the progress made in fish canning in Morocco, the speaker added that the number of automatic plants for fish processing now in use there is in the neighbourhood of twenty.

Still dealing with Mr. JUL's paper, Mr. CHEFTEL clarified a few points raised in the said paper relating to the I.M.C. automatic line for processing sardines. According to Mr. JUL, the automatic eviscerating equipment intended for this line are already in use in factories. Mr. CHEFTEL emphasized that while a series of such machines has already been built, they cannot yet be considered to be entirely satisfactory in service.

The great difficulty encountered in removing sardine heads and viscera is due to the extreme friability of this fish - none of the existing machines, either for sprats (which, moreover, do not need to be eviscerated, while sardines must be) or for herrings, is suitable for sardines. It cannot therefore be said that the problem has been solved. However, thanks to the studies being carried on in this field by Mr. SANDERS (International Machinery Corporation, Belgium) in conjunction with Mr. CHEFTEL, a satisfactory solution of this problem within the near future can be looked forward to.

After having pointed out that, in addition to head-removing machinery prototypes of machinery for sorting sardines by size and arranging them before they are put into the mechanical head-removers have been perfected, Mr. CHEFTEL asked the United States delegates what results had been obtained on an industrial scale with shrimp peeling machinery of which several types are believed to be undergoing trials in the United States.

Mr. DUFFY (Chief, Bureau of Food and Drug Inspection, California, U.S.A.) stated that as far as he knew shrimps are still peeled by hand in Louisiana.

b. Sterilization processes

Mr. FEIGENBAUM (Food Industries Department, Ministry for Agriculture, Israel) asked Mr. BALL if he could give more precise data as to the present status of studies relating to the use of X-rays for sterilizing canned foods. The speaker has personally done research work in this field and is not convinced of the practical efficiency of this process.

Mr. BALL (United States) emphasized that although he had not personally taken part in the work on electronic or X-ray sterilization, he believed that recent experiments had led to satisfactory results with certain radiations, but difficulties had been encountered with regard to the destruction of the enzymes. Experimental results appear to have shown that it is more difficult to eliminate enzymatic action by irradiation than it is to destroy micro-organisms. Mr. BALL would like to hear what Mr. CLIFCORN, who is particularly familiar with this problem, has to say about it.

Mr. CLIFCORN (Director, Fundamental Research, Continental Can Company, United States) confirmed Mr. BALL's opinion and mentioned, by way of an example, that according to the work done recently at the Massachusetts Institute of Technology on sterilization by cathode rays, X-rays and γ rays, it would appear that the quantity of irradiating energy necessary to destroy the enzymes is of the order of 3 to 4 million Roentgen units. Under present experimental conditions 2 million Roentgen units have currently been reached; but when foodstuffs are subjected to the action of 2 to 3 million Roentgen units in order to ensure complete inactivation of the enzymes, destruction of the natural properties of the products is commenced at the same time.

Mr. ROSKIS (France) would like to know what are the effects on the personnel of the high temperatures and pressures prevailing in the sealed canning and seaming rooms of the Smith-Ball process, and asked Mr. BALL if any industrial observations are available on this point.

Mr. BALL (United States) stated that it was quite true that the pressure prevailing inside the conditioning and sealing rooms of the Smith-Ball line is of the order of 17 to 20 pounds per square inch (1.2 to 1.4 kg/cm^2), which should normally correspond to a temperature of 260°F (126°C) which would make it impossible for the personnel to carry out their work. However, the super-pressure is maintained by means of conditioned air, the temperature and moisture content of which are carefully controlled. Air circulation in the rooms is ensured by a compressor which drives the air through water jets to adjust its temperature and moisture content at a suitable level, so that ideal working conditions are obtained. It is nevertheless a fact that the super - pressure prevailing in the rooms exceeds normal atmospheric pressure, but this has no ill effects on the personnel accustomed to work under these conditions.

Mr. KOVACS (Israel) would like to know whether the "Stero-Vac" process is still used in the United States and whether it has been further improved.

Mr. BALL (United States) and Mr. CLARK (United States) replied that this process had been abandoned owing to its unsatisfactory results.

c. Canned vegetables — Blair process

Mr. KOVACS (Israel) asked Mr. CLARK for data with regard to the Blair process for preserving the green colour of peas by an alkaline treatment, specifically as to the extent to which this process is used industrially and the attitude of the public towards the resultant products.

Mr. CLARK replied that this process has been in use for some years in two large American canning factories for a production of some 300,000 cases per annum. The cost price of peas treated by the Blair process is somewhat higher than that of others, while on the other hand they must be stored at a lower temperature than that used for ordinary canned peas. Storage for five weeks at least appears adequate.

Mr. CHEFTEL, Chairman of the Meeting (France) pointed out in this connection that laboratory tests made by him in France have shown that it is necessary to store canned peas at a low temperature in order to retain their natural green colour. It is therefore his impression that when appertized peas are stored at a low temperature after sterilization in a continuous autoclave at a high temperature, it is not essential to subject them to the alkaline treatment to improve their colour substantially. He would like to know Mr.CLARK's opinion.

Mr. CLARK felt unable to express any definite opinion on this point, but he added that when the Blair process is carried out under properly controlled conditions its effects are quite remarkable. The colour of the peas is a bright green which closely approaches their original colour, provided, of course, that they were green to start with, because the process cannot make the peas greener that they were originally.

d. Canned fruits (and vegetables) — Ascorbic acid

Mr. BORGSTRÖM (Direktor, Svenska Institutet for Konserveringsforskning, Sweden) raised the question of the use of ascorbic acid and expressed his surprise at the fact that it is not mentioned in any of the papers. Alluding to the considerable research work done in this field in the United States, he felt that the addition of ascorbic acid had become "the corner stone of all questions relating to canned fruits and vegetables", not only with a view to increasing their nutritive value but also as a technical facility for the industry, particularly in order to preserve the flavour of fruits and vegetables.

In his opinion the problem is of ever-increasing importance owing to the fact that the natural vitamin C content of vegetable foods is subject to substantial variations according to seasonal and climatic conditions of cultivation, and that it is very difficult to ensure preservation of the natural ascorbic acid. This is why in certain countries, such as Canada, the regulations require the addition of ascorbic acid to apple juice.

With regard to fruit juices Mr. BORGSTRÖM mentioned the important place they have taken in the United States canning industry, while in Europe their production only represents a small percentage. He feels that the great development of the American fruit juice industry is connected with the development of research work on tin and metal containers, while in Europe glass containers, which are extremely costly, are still adhered to for packing fruit juices.

In his opinion fruit juices should not be looked upon solely as finished products, but should also be used as semi-manufactured products for making other articles, such as purées.

Finally, Mr. BORGSTRÖM dealt with certain economic aspects of the problem of processing vegetable foods, pointing out the tendency to make greater use of refrigeration in order to extend the seasons when fruits and vegetables are used. He wondered what would be the repercussions of a European organization of cold storage warehouses on the canning industry ?

In France and Italy large capital sums have been invested in cold storage warehouses. These investments may one day lead to a decision as to whether stabilization by cold is not preferable to preservation in hermetically sealed containers.

Mr. BORGSTRÖM asked Mr. ADAM (Deputy Director, Fruit and Vegetable Preservation Research Station, Campden, United-Kingdom) whether the reports he had received from the various countries do not allude to the particular points raised by him.

Mr. ADAM expressed the opinion that the subjects dealt with by Mr. BORGSTRÖM are somewhat outside the scope of the program of the meeting, since they relate both to the scientific and to the economic aspects of the problem. However, in reply to the questions put, he stated that in the reports which have reached him he has not found any allusion to the addition of ascorbic acid or to its effects on the colour and flavour of canned vegetable products.

With regard to the retention of ascorbic acid in canned foods, considerable work has been done along these lines, but it would be beyond the scope of this meeting to go into details about it. Mr. ADAM was of opinion that the addition of ascorbic acid is not of any very great value in itself. It may be advantageous in connection with colour, for instance, in the case of cauliflowers or celery, when blanching is done without citric acid; but it does not appear to be of interest from the view-point of improving the flavour of fruit and vegetables.

The utility of ascorbic acid is more obvious in the case of frozen products, since it obviates changes in colour during de-freezing.

The reports from the various countries do not make any mention of purées either. It is known, however, that the production of certain purées has increased considerably in the United States.

As to the question of cold storage warehouses, this is more in the nature of a domestic problem which is peculiar to each country. Obviously, the extension of cold storage warehouses makes it possible to prolong the seasons when certain products are used, but Mr. ADAM felt that the purely economic advantages are not very great in this field.

Mr. CHEFTEL pointed out that the question of adding ascorbic acid will be dealt with, at least from the viewpoint of protection against non-enzymatic browning of products, by Mr. LEA (Low Temperature Research Station in Biochemistry and Biophysics, University of Cambridge, United-Kingdom) in a paper submitted to the Scientific Section (No. XXXVII).

On the other hand, he drew attention to the research work done in France by Messrs. DUROCHER and VOINOVITCH on enzymatic browning, which has led to interesting results, at the same time demonstrating the complexity of browning problems. In particular, it has shown that thiamin (vitamin B_1) is much more efficient than ascorbic acid in preventing certain enzymatic brownings.

With regard to the fact that the consumption of fruit juices in Europe, especially in Latin countries, is not very large, Mr. CHEFTEL felt that this is due, as he had already had occasion to point out a few years ago in response to Mr. KERTESZ in an article published in the English periodical "FOOD", to the differences between the eating habits in Europe and in the United States, on the one hand. Fruit juices are consumed in the United States mainly at breakfast, while in Europe breakfast cannot be called a meal in the same sense as on the other side of the Atlantic; and, on the other hand, to the fact that the purchasing power of the European public is unfortunately too low, so that fruit juices are a luxury.

Mr. BORGSTRÖM (Sweden) expressed the opinion that the reason for the considerable development of fruit juice consumption in the United States is to be found in the education of the public in matters connected with food. Thus, European immigrants who from the major part of this public have changed their methods of nourishment.

With regard to freezing, Mr. BORGSTRÖM explained that it had not been his intention to raise the problem in general, but only the aspects of its use as a means of pre-preservation, for instance, in the jam-making industry.

In the same way, his remarks on metal containers were not directed to the problem as a whole, but were made simply in connection with his question about fruit juice. He felt it would be of interest to European canners to learn why more fruit juice than any other product is packed in cans in the United States.

Finally, his remarks on ascorbic acid were not intended to deal with the scientific aspect of the problem but solely with its technological aspects which appear to him to be of considerable importance and not to have been given sufficient attention in Europe.

e. Canned fruit: vacuum syruping and sealing

Mr. CARVALLO (France) alluded to recent American tendencies to replace standard thermal exhausting in fruit canning lines by vacuum-syruping followed by vacuum sealing or sealing under steam jet. He reminded delegates that for many years as lengthy exhausting as possible was recommended, so as to remove the intra-cellular air of the products from the container. He therefore asked whether in the new systems without exhausting, operating at high speeds of the order of 200 or 250 cans per minute, in which the can is subjected to the action of the vacuum for only about one second, the treatment suffices to eliminate air completely from the contents of the can ?

Mr. ADAM (United-Kingdom) expressed the view that efficient evacuation of air in the systems of vacuum-syruping and sealing depends first of all on the machinery used and the length of time during which the vacuum is maintained. Thus, for instance, in twelve-head machines the time during which the cans are subject to the action of the vacuum is fairly long.

With regard to any "intra-cellular air" which might not be eliminated during these operations, Mr. ADAM did not think that the concept of "air" (assimilated to that of oxygen) is correct; for work done in Great-Britain on fruit has shown that practically no oxygen remains in the cellular tissues and that, in fact, almost solely nitrogen and carbonic acid gas are involved. Finally, he asserted that after steam vacuum closure even less oxygen remains in the can than after the usual sealing processes.

Mr. CLARK (United States) confirmed what Mr. ADAM said with regard to the time for which the cans remain in the vacuum machine, and pointed out that the new process had been used in California for the past six or seven years without any instances of accelerated corrosion having been recorded, although they would certainly have occurred if the oxygen had not been adequately evacuated.

Mr. CHEFTEL expressed the opinion that steam - vacuum closure is preferable to thermal exhausting carried out without clinching. If a cold lid is added on the can when it comes from the exhauster a considerable part of the benefit of the exhausting is lost. He considered that it would not be possible to take up the question of vacuum-syruping as a technical problem until it could be contemplated at the rate of 250 cans per minute, for, in fact, the machines necessary for this work would not be justified otherwise as the cost per can would be excessive.

f. Fruit preserves: copper and stainless steel equipment

Mr. MATERNE (President of the Groupement des Fabricants de Confitures, Pâtes de Pommes, Conserves de Fruits et Fruits confits, Belgium) would like to know why, in the United-Kingdom, ever-increasing use is made of extra high speed copper pans for jam-making. This appears to him to be in contradiction with the prevailing tendency in the United States to use preferably stainless steel. Is this to be taken simply as showing that the advantage of the heat conductivity of copper outweigh the drawbacks of metallic contamination of the jam by the metal ?

Mr. HINTON (British Food Manufacturing Industries Research Association, United-Kingdom) thought that the preference for copper was due to its greater heat conductivity, which is felt to outweigh the drawbacks of catalytic destruction of the ascorbic acid. After all, apart from certain jams made of strawberries and other berries, the anti-scorbutic properties of jam are not very great.

g. Miscellaneous questions: bacteriological aspects

Mr. GUILLOT (France) deplored the indequacy of present knowledge of the bacteriology of acid-producing thermophile germs, which play such an important part in the technology of canned vegetables. He drew attention to the lack of precision found habitually in works on these micro-organisms. In the latest edition of the Bergey's Manual and in recent books on food bacteriology it is to be noted that these germs, particularly those of the heat-resisting species, are sometimes described as bacilli, sometimes as rod bacteria, cocci-bacilli, sometimes as Gram - positive and Gram - negative, sometimes as sporulated or non-sporulated, mobile or non-mobile. Moreover, no one knows their biological character, the conditions under which they bring about a reduction of the pH, the time which elapses before a reduction of the pH occurs, the temperature most favourable to such reduction, etc.... The speaker concluded that a systematic and thorough study of these germs is necessary.

Miss ASCHEHOUG (Chief of the Bacteriology Department, Hermetikkindustriens Laboratorium, Norway) concurred in Mr. GUILLOT's remarks and mentioned that a fairly thorough study or thermophile bacteria in canned meat, vegetable and fish products has just been completed in Norway and will be published in the November, 1951 issue of "Food Research".

Mr. LEFEBVRE (Chief of the Laboratory of the Institut national pour l'Amélioration des Conserves de Légumes, Belgium) intervened to raise a question connected with the chlorination of cooling water for processed cans, in order to avoid spoilage by swelling due to reinfection of the products by contaminated water penetrating through the micro-leaks in the cans. He asked what was the probability of having fermentations by non- gazogenous bacteria when a comparatively small quantity of chlorine is used in the cooling water the original contamination of which is fairly high. Under these conditions one has to deal, more often than not, with bacilli of the subtilis and mesentericus type, the spores of which can withstand small quantities of chlorine. Mr. LEFEBVRE would like to know whether similar cases have been encountered frequently when inspecting canned foods.

Mr. BUTTIAUX (Chef de Service, Institut Pasteur de Lille, France) pointed out that the question of cabilli was to be dealt with in detail when his paper was submitted to the scientific section. He intended to take the matter up again at that meeting and to study, in particular, the question of enterobacteriae which have a so - called anarchic metabolism and which are alleged never to produce any gases; it is even thought that in certain circumstances these germs are capable of becoming aerobian.

Mr. CHEFTEL pointed out that what was necessary was not to study the bacilli but to find out whether, if a very small quantity of chlorine is added to the can cooling water, there is a danger of bringing about a selection of microbes and causing the presence together of specific species which are all the more difficult to deal with in that they do not give rise to swelling of the can, so that it is not possible to see immediately that the contents have been contaminated owing to leaks.

Mr. BUTTIAUX stated that in his opinion the question of chlorination of the water is of secondary importance as far as bacilli are concerned, for bacilli seldom contaminate water. The most dangerous contaminators of canned foods are entero-bacteriae.

Mr. CHEFTEL mentioned briefly the question of the use of subtilin as an auxiliary agent for stabilizing canned vegetables, which was dealt with in the papers submitted, pointing out that he had thought of using this antibiotic for semi - preserved foodstuffs. The results obtained have shown that even in this field subtilin appears to be completely inefficient for products such as anchovies, on the one hand, and olives on the other hand.

FOURTH MEETING

(Thursday, October 18 - morning)

AGENDA : Legislation.

CHAIRMAN : C.A. ADAMS, Director, Food Standards and Labelling Division, Ministry of Food (United-Kingdom).

PAPERS SUBMITTED :

1. Food laws and enforcement in the United States, paper No.XXVI, submitted by the author, C.H. BLOEDORN, Manager of Technical Services, Continental Overseas Corporation (United States of America), and accompanied by a statement by Mr. Milton P. DUFFY, Chief, Bureau of Food and Drug Inspection (California) on the enforcement of the Federal Law and State Laws concerning food in the United States.

2. Some comparisons between food legislation of various countries, paper No.XXVII, submitted by the author, C.L. HINTON, Superintendant of Research, British Food Manufacturing Industries Research Association (United-Kingdom).

SUMMARY OF DISCUSSION

The following questions, in particular, were dealt with during the discussion :

a) explanations as to American legislation and its enforcement by the Food and Drug Administration;

b) specific problems relating to the statement of weight on preserved food containers with a covering liquid (page 7);

c) general remarks on international legislation on food (page 8).

a. Explanations as to american legislation

Mr. FEIGENBAUM (Food Industries Department, Ministry for Agriculture, Israel) asked for explanations of the method of setting up standards in the United States and of recruiting Inspectors of the Food and Drug Administration and their status.

Mr. DUFFY (United States) replied that anybody can take the initiative of setting up or changing standards. Once an application for the establishment of a standard has been filled, it is for the Administration to take action thereon. It makes known its intentions by correspondence or through the technical press of the branch, and asks representatives of the industry concerned to state their views at public meetings. In drawing up and publishing standards, the Administration takes the views exchanged at these public meetings into account.

Inspectors are recruited by examinations conducted by administrative commissions specialised in the various branches of the food industry. Candidates are almost always graduates in chemistry, agronomics, pharmacy or biology. Those who pass the examination are sworn and become State functionaries in the same manner as members of the Police Force. They carry out their duties in complete independence of the industry or profesional organisations.

In response to a question by Mr. PILNIK (Director of Resarch, Central Citrus Products Research Laboratory, Israel) as to the Inspectors' powers and possibilities of taking immediate action, Mr. DUFFY explained that if irregularities or non-compliance with the regulations or standards in force are ascertained, it is the inspector's duty to take immediate action by informing his superior of the facts. The latter takes the necessary steps.

Mr. BLOEDORN (United States) added in this connection that the inspectors' powers and authority are strengthened by the fact that the manufacturer runs the risk of having his products withdrawn from sale, in whole or in part according to the case, if he takes no notice of the inspectors' instructions dealing with improvement of working conditions or the products so as to bring them into line with regulations.

Mr. LAGNEAU (Director of Union nationale des Fabricants de Conserves de Fruits et de Confitures, France) asked what were the rules applied in the United States in the event of conflict of jurisdiction between the State legislation and the Federal legislation, in view of the fact that the former may differ from the latter on certain points. He reminded the meeting that in France the penal laws applicable to fraud or falsification take the intention into account, that is to say, a penal sentence is inflicted only if there has been had faith on the part of the delinquent, while if there has not been bad faith, then there is simply a misdemeanour in the nature of a tort, which exists even if a purely involuntarily infringement of the regulations has been found to exist. He would therefore like to know what is the position as regards the laws and regulations in force in the United-States in this connection, and, in particular, whether they take the delinquent's intention into account.

Mr. BLOEDORN (United States) explained that under the American Constitution the federal States are sovereign. Consequently, in the event of conflict between the two legislations, the State legislation prevails. In any event, so long as a product does not go outside of the frontiers of a State it does not come within the scope of the federal laws and is governed only by the local law. In this connection he cited the case of a manufacturer domiciled in the State of Illinois who was approached by the federal authorities with a view to his ceasing the manufacture of a specific product; but as the product in question did not

infringe the State legislation, it is to be found on the market throughout the State of Illinois. It is only if the producer endeavours to market his product in neighbouring States that the federal authorities take steps to seize it.

Mr. DUFFY (United States) added that, generally speaking, State legislation on foods is the same as federal legislation. This applies, in particular, to California. However, there may be differences in details, for instance, as to the fat content of milk; but they do not relate to questions of purity or other basic points. In the same way, there are differences between the various State legislations as to the use of sulphur dioxide, some of them prohibiting or restricting its use for certain fruits, etc....

As to the problem of fraudulent intention, Mr. BLOEDORN emphasized that although this possibility is not provided for in the law, the authorities take the delinquent's good or bad faith into consideration when deciding whether criminal or civil proceedings shall be taken against him.

In Mr. DUFFY's opinion, whatever may be the producer's intentions he is deemed to assume a certain responsibility for the products he places on the market. This explains why American law makes no distinstion between deliberate fraud and involuntary fraud. On this point the legislation of the individual States is the same as the Federal law.

As to whether the Food and Drug Administration is in charge of supervising the quality of foodstuffs, Mr. BLOEDORN stated that, in principle, this Administration is not interested in quality as such. Its immediate task is to ensure that products shall be perfectly suitable for consumption and in accordance with the regulations in force. However, questions of quality fall within the province of the Administration whenever official standards of quality are published, as is the case for numerous products. On the other hand, if the label bears a quality indication which is not in accordance with the facts, the product can be seized on the ground of misrepresentation.

Mr. GUILLOT (France) asked whether any regulations exist in the United States on the state of health of the personnel handling food in canneries, particularly with regard to healthy carriers of pathogenic germs of the salmonella, typhoid and paratyphoid groups.

Mr. DUFFY replied that Californian regulations, which are practically identical with those of the other States, stipulate that no one suffering from an infectious or contagious disease may be employed in food factories. Obviously, these regulations apply only to the present, for a workman may be in a perfect state of health when he is engaged and subsequently become a carrier of pathogenic agents. In Pasadena (California) systematic inspections are made of all the personnel employed in food factories, but the results have not been found to be conclusive except for the detection of venereal disease.

Mr. KNOCK (Metal Box Company of South Africa, Union of South Africa) stated that in South Africa it was proposed to promulgate a sanitary code shortly for workers in the foodstuff industry. In this connection the question was raised as to whether workers in food factories should be classified among the personnel subject to periodical medical examinations. Although it is indisputable that all contagious disease should be eliminated, it may be asked whether, in practice, this can have any influence on canned products. In conclusion, Mr. KNOCK would like to know whether there are any countries where the law requires " bacteriological " examination of the workers in food factories as a condition of their employment.

Mr. DUFFY (United States) replied that Californian law stipulates that no foodstuff manufacturer may use the services of workers suffering from infectious or contagious diseases, more particularly the following : smallpox, diphteria, yellow fever, tuberculosis, bubonic plague, cholera, leprosy, sarcoma, typhoid fever, dysentery, mumps, measles, whooping cough.

With regard to venereal disease, American laws go far beyond the circle of workers in the food industries, for anyone suffering from a venereal disease who is not undergoing treatment can be interned by order of the authorities in a hospital where he is forced to undergo treatment.

The speaker added that in his 37 years' experience of inspection of food factories in the State of California he has never met with any case calling for action by the Authorities to enforce the regulations in this field.

b. Statement and determination of net weight of contents

Mr. CADBURY (Managing Director, British Canners Ltd., United-Kingdom) intervened several times in the discussion and raised the problem of the indication of the net weight on the labels of canned foods with a covering liquid (syrup, brine). He pointed out the present tendency in the United-Kingdom to state the drained net weight of the product, and emphasized that this method of indicating the weight raises a serious practical problem in a certain number of cases, in particular in that of fruits and berries in syrup, owing to the substantial variation in the drained net weight combined with the phenomena of osmosis and exudation.

He would therefore like to know the substance of the laws in force in various countries, more particularly in the United States, on this subject. Do they require that the total net weight of the contents be stated, or only that of the drained solid product ? In the latter case, how is allowance made for the excessive exudation of certain fruits, such as strawberries in syrup, for instance ?

Mr. DUFFY (United States) replied that the requirements of United States law vary according to the product and the covering liquid. In the case of products in syrup - that is to say, covered by a liquid containing nutritive substances which are really consumable - the total net weight must be stated, while in the case of vegetables covered with brine - such as whole spinach or asparagus, for instance - the indication of the drained net weight of the solid product is compulsory. Tolerances are permitted both for the determination of the drained weight and for that of the total net weight.

Asked by Mr. LAGNEAU (France) to state what is the French law on the subject, Mr. GROSS (Principal Inspector of Repression of Fraud, Ministry of Agriculture, France) said that although, to date, there is no complete set of regulations in France governing canned foods and the method of labelling them, the tendency is more and more towards the principle adopted in the United States, that is to say, to require that the weight shown on the label shall be the net weight available to the consumer. The authorities in France are on the point of laying down regulations for the indication of the net weight on the containers of canned foods,

under which the actual consumable net weight of the product must be given. In the case of foods covered with brine, only the net, drained weight will be taken into consideration. In certain special instances, however, the statement of the utilisable net weight may be replaced by the indication of the number of pieces contained in the can, together with their size. In this manner the consumer will know exactly, in all cases, what is the quantity of consumable product to be found in the container he purchases.

Mr. HINTON (United-Kingdom) pointed out that certain countries in Latin America and Europe require, in addition, the indication of the drained weight in the case of preserved fruit, in some cases.

Mr. KNOCK (Union of South Africa) said that in South Africa the products for which the drained weight must be given are determined by the standards in force, which also lay down the minimum required weight, although it is not compulsory to state the drained net weight on the label.

Mr. ADAM (Deputy Director, Fruit and Vegetable Preservation Research Station, Campden, United-Kingdom) intervened to point out that Canadian legislation also contains a fairly long list of products as to which a minimum drained weight is required, and that canned fruits are included in this list. On the other hand, Canadian legislation gives a precise definition of the minimum weight and how it shall be determined. The latter is done by taking a certain number of samples, and the rule lays down that these samples must not include more cans containing less drained weight than that stated on the label than it includes cans of which the contents weigh more than is stated on the label.

The question of the weight after draining in the case of fruit, and more especially of berries, gives rise to numerous considerations, for the drained weight of berries represents two-thirds of the net weight, which can give the consumer a wrong idea. It is therefore found preferable, in England, to have the product placed in the container controlled by inspections at the factory itself, so as to check the actual net weight of the product before the can is sealed and not afterwards, in the form of the drained product. On the other hand, when the drained weight is determined by taking a given number of samples, allowance is made for accidental insufficiencies in the filling weight, for which certain tolerances are permitted.

In reply to a question by Mr. ADAM (United-Kingdom) as to the tolerances permitted in the United States in determining the weight stated on the label, Mr. DUFFY explained that these tolerances are not made known to the public in order to avoid deliberate abuses in filling, since manufacturers, if they were aware of the official tolerances, might be inclined to place only the strict minimum of the product in the cans.

With regard to canned fish, Mr. JUL (Chief of the Technology Branch, Fisheries Division, Food and Agriculture Organization of the United Nations) stated that in Denmark the drained weight is given for fish in brine and the total net weight for products in oil.

He also mentioned that the F.A.O. has made a study of this question in connection with fishery products and has summarised the situation in various countries in a report which can be obtained on request from its specialised departments.

c. International aspects of food legislation; necessity of co-ordination the national laws of the various countries

This necessity was mentioned several times during the exchange of views on the statement of weight on the labels of containers. It was taken up more explicitly following the remarks made by Mr. LAGNEAU (France).

Referring to Mr. HINTON's (United-Kingdom) statement with regard to the legislation in force in various countries, Mr. LAGNEAU deplored the fact that in numerous cases national regulations make no provision for the protection of descriptions of origin. He felt that public regulations should not only protect the consumer from the point of view of the hygienic and chemical properties of food, but should also give prominence to their organoleptic qualities. The latter depend on well-defined factors such as climate, cultivation or breeding soil, species or variety of raw materials used, etc.. National laws and international treaties do protect descriptions or origin, but this problem should be studied on an international level so as to put an end to names such as "Australian Sauternes" or "American Sardines". In conclusion, he expressed the hope that a resolution could be adopted by the Congress along these lines.

Mr. HINTON (United-Kingdom) pointed out that certain countries have already adopted the principle of protecting descriptions of origin, though in a different manner. The attitude of French regulations in this field is well known. In the United-Kingdom descriptions of origin are also covered by definite legislation which stipulates that the description of the product must be so formulated as to leave the consumer in no doubt as to the origin of the product. Thus genuine port wine is to be found on the English market side by side with wines labelled "Port type", which, thanks to the word "type" are easily distinguished by the purchaser.

Similar regulations exist in Denmark with regard to cheese.

Mr. HALDEN (Austria) concurred with the views expressed by Mr. LAGNEAU. He thought there was a universal desire to establish international regulations on food qualities. He mentioned the Austrian Food Code which is now being revised and redrafted with a tendency to be inspired by and brought into line with the legislation of other countries. This tendency would be promoted by international contacts bringing together specialists from several countries to ascertain and formulate the questions of which a study should be undertaken. As far as he is concerned, Mr. HALDEN has been in touch with English and American scientists who are prepared to meet together in order to work out basic rules on points of the greatest importance from the point of view of health, such, for instance, as colouring materials for foodstuffs.

Mr. ADAMS (United-Kingdom, in the Chair) agreed that the harmonisation of the various national regulations is incontestably a very live problem at the present time. He is a member of a committee comprising representatives of Canada, the United States and the United-Kingdom, whose task it is to keep a watch over any new laws which may be put into force in the three countries. In the same way, the United Nations Organization takes a great deal of interest in the problem of unifying food regulations. Finally, the countries which signed the Brussels Pact have also held several meetings in an endeavour to bring out the possibility of achieving greater uniformity in this field.

In conclusion, Mr. ADAMS felt it could be asserted that the door is ajar and it would perhaps suffice to open it wide for an international congress, such as the 2nd International Congress on Canned Foods, for instance, to devote thorough study to the problem and put forward suggestions and proposals along these lines.

Mr. CADBURY (United-Kingdom) made a point of calling the attention of the United States delegates, whose country has not yet adhered to the C.I.P.C., that the said international organization appears to him qualified to go further into this question. He therefore expressed the hope that it would be raised on the C.I.P.C. in the near future.

Mr. JUL (F.A.O.) said that the F.A.O. is fully aware of the necessity of introducing uniformity into national regulations, but it is also fully aware of the difficulties involved for each of the countries concerned. Nevertheless, F.A.O. is making a study of the regulations in force in the various countries and hopes to be able to make minimum recommendations applicable in all countries. International meetings on the subject are being organised and it goes without saying that F.A.O. would be much encouraged if bodies such as the present Congress adopted resolutions along these lines and gave it their support.

Mr. CHEFTEL (Chairman of the Scientific Committee of the Comite international permanent de la Conserve, C.I.P.C.), wished to assure Mr. JUL that the C.I.P.C. would be only too glad to co-operate to the utmost whenever F.A.O. might wish to consult canned food manufacturers, through the C.I.P.C., on draft international regulations.

FIFTH MEETING

(Thursday, October 18 - afternoon)

ECONOMIC SECTION

This section of the fifth meeting, presided over by Mr. E. MAYOLLE, Vice-President of the Conseil national du Patronat français, was reserved for the submission of papers on the cost and availability of canned foods compared with home cooked foods.

Papers Nos. XXVIII, XXIX, XXX, XXXI and XXXII were presented.

It was not possible to make a detailed record of the discussion which followed the submission of these papers, but it should be mentioned here that they aroused very great interest among congress members. The latter asked, on the one hand, that a more important place should be given economic questions at forthcoming international congresses on canned foods, and, on the other hand, that on the basis of the above-mentioned papers, the C.I.P.C. should direct its efforts to making widely known the data in the economic field which, if they are made more extensively available to the public, can efficiently contribute to the development of canned foods in the various countries.

SCIENTIFIC SECTION

AGENDA : Bacteriology of deliberately non-sterile canned foods and non-enzymatic browning.

CHAIRMAN : Professor M. MACHEBOEUF, Chef de Service, Institut Pasteur de Paris (France), then Miss V. ASCHEHOUG, Chief of the Bacteriology Department, Hermetikkindustriens Laboratorium (Norway).

PAPERS SUBMITTED :

1. The bacteriology of semi-sterile fish preserves, especially "gaffelbiter" and "anchovies", paper No. XXXIII, submitted by the author, Miss V. ASCHEHOUG.

2. Studies on the production of anchovies at the Portuguese Institute for Fish Preservation, summary of the studies of Professor Ch. LEPIERRE (†) and J. MERCIER-MARQUES, paper No. XXXV, submitted by J. MERCIER-MARQUES, Chemical Engineer (Portugal).

3. The bacteriological examination of canned hams, paper No. XXXVI, submitted by the author, R. BUTTIAUX, Chef de Service, Institut Pasteur de Lille (France).

4. Studies on the processing of foie-gras, paper No. XXXIV, by P. FLEURET, J. DUROCHER, Miss M.L. THUILLOT, Miss C. TARDIVON and H. CHEFTEL, submitted by the last-named.

5. Non-enzymatic browning, paper No. XXXVII, submitted by the author, C.H. LEA, Low Temperature Station for Research in Biochemistry and Biophysics, University of Cambridge (United-Kingdom).

SUMMARY OF DISCUSSION

The following questions were taken up :

a) bacteriology and related problems concerning deliberately non-sterile canned fish, particularly anchovies (page 10);
b) bacteriology of deliberately non-sterile canned meat (page 10);
c) non-enzymatic browing reactions (page 11).

a. Bacteriology and related problems concerning deliberately non-sterile canned fish, particularly anchovies

Mr. BARNES (H.J. Heinz Company Ltd., United-Kingdom), referring to the papers submitted on anchovies, asked whether the bacteriological examination by itself is sufficient to permit an opinion to be formed as to the quality of deliberately non-sterile canned anchovies. In this connection he mentioned the particular instance of English preparations of anchovies which have been found to be satisfactory from the bacteriological point of view, but which were unsuitable for consumption on account of their high content of free fatty acids, amounting to as much as 60 or 75 %. This would seem to prove that the bacteriological examination is not sufficient and should be completed by a chemical analysis of the product.

Miss ASCHEHOUG (Norway) remarked that the question of examining products is often very complicated. In many instances bacteriological and chemical examinations are still not sufficient, and the organoleptic of course, that the can has not become swollen.

Mr. LEA (United-Kingdom) pointed out that the deterioration of the fatty substances may be due to the activity of lipolytic enzymes. He therefore was not of opinion that the content in free fatty acids could be a basic indication with regard to the preservation of the product from the bacteriological point of view.

Mr. LOPEZ-CAPONT (Director of Technical Department, Unión de Fabricantes de Conservas de Galicia, Spain) mentioned that in the anchovies processed in Spain proportions of oleic acid as high as 2 % have been observed. All Spanish preparations are made with olive oil, of which the content in free fatty acids is of the order of 0.1 to 0.15 % of oleic acid. In old cans contents in oleic acids have been noted ranging from 0.2 to 2 %. He did not think that the high proportion of free fatty acids was due to bacterial activity because in the cans which were opened and which had an oleic acid content of the order of 2 % no increase in the proportion of oleic acid was ascertained after the can had been left for a week at room temperature.

Mr. GUILLOT (France) expressed the hope that one day a systematic method of testing and examining deliberately non-sterile canned fish would be worked out, in the same way as that recommended by Mr.BUTTIAUX for the bacteriological examination of hams. He wondered whether this method could not, at least as to certain germs, be applied to deliberately non-sterile canned fish; the importance of the problem is obvious, in particular as regards the detection of the Cl. botulinum and of staphylococci. The presence of the Cl. botulinum in pilchards was reported recently by Mr. PREVOT, of the Pasteur Institute in Paris. As to enterococcic staphylococci, they are among the germs which thrive on salt and their presence in canned mackerel has been reported in Italian and Portuguese papers.

Miss ASCHEHOUG (Norway) shared in the hope expressed by Mr. GUILLOT. In this connection she mentioned the procedure adopted in Norway for the inspection of deliberately non-sterile canned fish intended for export and which involves the following stages: incubation at 22°C for three weeks, followed by an organoleptic examination of a representative quantity of cans taken from the batch, and a search for available antiseptics.

Mr. HINTON (United-Kingdom) raised the question of the use of hexamethylene-tetramine for the preservation of deliberately non-sterile canned fish. Pointing out that this antiseptic is permitted in Norway, Sweden and Germany, he asked whether sufficient proof is available that it is harmless from the toxicological point of view.

Miss ASCHEHOUG (Norway) stated that the advantage of hexamethylene - tetramine is that it does not have any hardening effect on the flesh of the fish, so that it can be said to be an ideal antiseptic for deliberately non - sterile canned foods. The permitted proportions are extremely small : thus, Norwegian regulations allow the incorporation in deliberately non - sterile canned fish of 500 mg of benzoic acid per 100 g of product, and of 50 mg of hexamethylene-tetramine; the latter, moreover, disappears during the heating of the product.

Mr. MEESEMAECKER (Technical Director of the Laboratories of the Fédération des Industries de la Conserve au Maroc, Morocco) brought up the problem of the use of antiseptics on a more general scale and felt that the question was worth thorough study.

Mr. CHEFTEL (France) was of the same opinion, and suggested that this subject be placed on the agenda of the 3rd International Congress on Canned Foods. Mr. CHEFTEL took the opportunity to make a few remarks concerning anchovies, in order to avoid any confusion in the minds of the audience. Care must be taken to distinguish between the so-called "Norwegian" anchovy as prepared in the Nordic countries from sprats, and the anchovy prepared in the Mediterranean countries and on the Gulf of Gascony using anchovies properly so-called.

These are, in fact, two different products. The Norwegian method of preparation consists in an anchovy processing which brings both enzymes and bacteria into play, since the quantity of salt added is not sufficient to saturate the water present in the fish. Anchovy processing as practised in the southern countries, on the contrary, is carried out by complete saturation with salt, which gives rise to an autolysis process protected against bacterial action.

In this connection the speaker mentioned studies which he has undertaken in collaboration with Mr. DEVEZE at the Endoume laboratory, and which are still going on. In spite of the fact that the results are still incomplete, these studies have led to ascertaining that there are bacterial species which can proliferate in a culture medium of which the salt content is higher than 20 %. It has also been found that the water present must be completely saturated if the product is to keep properly, and that it will not keep well if total saturation is lacking.

b. Bacteriology of deliberately non-sterile canned meats

Mr. CLARENBURG (Head of the Veterinary Department of the Public Health Institute, Netherlands) raised

the question of labelling canned hams. In view of the fact that these are only semi-preserved, non-sterile products, the preservation and wholesomeness of which are dependent upon the temperature at which they are stored, he felt that some visible indication on the container label should show clearly that they must be kept in a cool place. For commercial reasons, it is difficult, at the present time, for exporters from one country to do this when producers in another country do not. He therefore expressed the hope that an international agreement would make the labelling of canned ham containers in this way compulsory.

On the other hand, Mr. CLARENBURG would like to know what practical method there is of determining the possibility of preservation of semi-preserved foods in cans of the ham type. The presence of non-pathogenic bacilli cannot be recognised as sufficient ground for refusing a product of this type, because there is no way of knowing the number of bacilli which can be tolerated in a non-sterile canned meat. In his opinion manufactures must be controlled by incubation at a temperature below 35°C; for in order to avoid possible swelling, it is wise to incubate the cans at a temperature of 10 or 20°C. He would like to have Mr. BUTTIAUX' opinion on these points.

Mr. BUTTIAUX (France) also felt, as far as he was concerned, that an international arrangement should be made laying down regulations on the indications to be placed on containers of non-sterile canned meat along the lines suggested by Mr. CLARENBURG.

As to the method to be adopted in order to determine the possibilities of preservation of canned hams, it is not easy to suggest a choice. He did not think that a quantitative knowledge of the number of germs present is sufficient in this connection, in which the quality and character of germs are much more important. That is why he recommends the most detailed possible bacteriological examination of hams intended for export. If this examination does not reveal the presence of either Clostridium, or Enterobacterium or of Pseudomonas, it can be concluded that there is every likelihood - one can even say 99 chances out of 100 - that the product will keep perfectly.

With regard to the presence of Bacillus, it appears to be of somewhat secondary importance, for the simple reason that deterioration due to Bacillus is extremely rare. The Bacillus play, in practice, such a very small part that every time a can is found to have swollen due to the action of a Bacillus, no time is lost in publishing the fact in a scientific periodical. However, the fact remains that this question must not be lost sight of.

In conclusion, Mr. BUTTIAUX was of opinion that a complete bacteriological examination with systematic identification of the germs present suffices to furnish indications as to the preservation of the hams examined. In the method recommended by him, he advises incubation at 37°C, but only for 24 hours. This preliminary test appears to him to be all the most interesting in that it permits of eliminating swollen cans, for it is his opinion that a good canned ham must be able to withstand incubation at 37°C successfully for 24 hours. However, it would not be reasonable to continue this incubation for eight to fifteen days - as is done in certain foreign countries - and then to conclude, if there is swelling, that the product is of bad quality.

On the other hand, it cannot be definitely claimed that a product which has successfully undergone incubation for 24 hours at 37°C is to be deemed to be of good bacteriological quality. Such a conclusion would be too hasty and uncertain. The preliminary incubation test is all the more useful in that it promotes, in a way, the culture of all the germs existing in a latent state and which are capable of being brought to life; it thus substantially increases the chances of a positive bacteriological examination.

Mr. KNOCK (Metal Box Company of South Africa, Union of South Africa) intervened to remark that opinions on the bacteriological quality of hams are highly divergent. In this connection he pointed out that in South Africa any canned ham containing non-sporulated germs is considered unacceptable; the presence of non-sporulated species in a ham leads not only to the rejection of the can complained of, but of the whole batch of which it forms part.

Mr. BUTTIAUX (France) explained that the term " non-sporulated species " is a very general one; he therefore did not think it possible to adopt this point of view, because this would mean, in France and England, for example, rejecting approximately 90 % of the hams available on the market.

Mr. GUILLOT (France) would like to know the minimum time necessary for making a bacteriological examination of a ham according to the method recommended in Mr. BUTTIAUX' report. On the other hand, he asked what was the number of samplings to be made on a batch of canned ham in order to be able to form a valid opinion of its qualities. He deplored the lack of precise regulations on this last point, for in his opinion the examination of a single ham cannot be deemed sufficient to permit of drawing conclusions for a whole batch.

Mr. BUTTIAUX (France) stated that his method of bacteriological examination of hams usually takes an experienced tester four days.

Mr. JAKOVLIV (Etablissements Ed. MATERNE, Belgium) wished to know whether the ham canning industry has not tried to replace the gelatine by a low methoxyl pectin, which would have the advantage of being a non-putrescible jellying agent.

Mr. BUTTIAUX (France) did not think this method could be contemplated, because the ham jelly is, in a way, an accompanying sauce which gives the product specific gustative properties. Most manufacturers have a special little "know-how" in preparing ham jelly so as to give it a particular, delicate flavour which could not be obtained with pectin.

Mr. CHEFTEL (France) confirmed Mr. BUTTIAUX' opinion and reminded the meeting that the mechanical properties of jellies produce quite different gustative characteristics. A gelatine jelly which melts in the mouth or a pectic jelly prepared with a pectin with high methoxyl content - which is also malleable and not very elastic - produces quite a different sensation from that produced by an elastic jelly made with a pectin having a low methoxyl content.

c. Non-enzymatic browning reactions

Mr. ADAM (Deputy Director, Fruit and Vegetable Preservation Research Station, Campden, United-Kingdom)

reported on tests during which he noted the formation of the taste of malt, which is characteristic of non-enzymatic browning reactions, in products subjected to lengthy sterilisation at a low temperature. An increase in acidity was observed simultaneously, but it was not possible to notice any changes in the amino-acid, reducing sugar and carbonic acid contents. Similar observations have been made on products subjected to incubation at 55°C. The speaker would therefore like to know whether these changes are to be deemed to be phenomena belonging to the category of non-enzymatic browning reactions, and whether there is a chemical test by which this can be determined with certainty.

Mr. LEA (United-Kingdom) stated that there is doubtless a relationship of effect and cause between the phenomena of browning, on the one hand, and the duration and temperature of the heat treatment on the other hand. Thus, in the case of powdered milk it is recommended that high temperatures be applied only for the shortest possible time so as to avoid undesirable changes in colour.

With regard to the chemical tests which would enable the phenomena of non-enzymatic browning to be characterised without any doubt whatever, on the contrary, the question is a very complex one and research becomes more and more complicated the more one's knowledge of these phenomena is increased.

The phenomena of non - enzymatic browning are linked up with at least four different types of reactions. When a neutral pH is present, there can be no doubt of the fact that there is definite interaction between the amine group and the reducing sugars. But in the case of vegetable products, and more particularly of fruit, where the amine group does not intervene, the most important part in the browning reactions is played above all by ascorbic acid and the carbohydrates.

In reply to a question by Mr. PILNIK (Director of Research, Central Citrus Products Research Laboratory, Israel), Mr. LEA then explained that in the development of the browning reactions the maximum colour shown on certain curves corresponds to optimum relative moisture, rather than anything else, for the evolution of reactions which are superimposed on each other. Thus, in a study of the reactions occurring between synthetic proteins and glucose, it has been possible to bring out clearly two reactions: one - primary - which takes place between the aldehyde radicales of the glucose and the amine grouping of the protein and leads to the formation of a colourless condensation product. In a second stage of the reaction which occurs at a maximum of 60 to 65 % relative moisture, this product then becomes transformed into a very brown product.

Mr. HINTON (British Food Manufacturing Industries Research Association, United-Kingdom) expressed the view that in its present state the nomenclature relating to non - enzymatic browning reactions involves too many generalisations and abounds in concepts which are too vague. He wondered whether the day is approaching when it will be possible to define these reactions more precisely by giving them names which usually characterise chemical reactions.

Mr. LEA (United-Kingdom) replied that these generalisations are partly due to the fact that, in spite of the chemical individuality peculiar to each type, the non-enzymatic browning reactions have many points in common and, above all, bring about common effects. He nevertheless agreed with Mr. HINTON on the necessity of establishing to the fullest possible extent a new and more precise nomenclature for browning reactions. But as in many cases there is complete ignorance of all the details of these reactions, it is inevitable to use general terms in the meantime.

Mr. FEIGENBAUM (Food Industries Department, Ministry for Agriculture, Israel) pointed out that in the case of several products, particularly fruits and citrus juices, thiourea has been found to be a valuable inhibitor of browning reactions. The drawback of thiourea, however, is its toxicity.

Mr. LEA (United-Kingdom) stated that in the case of citrus juices, especially orange juice, the browning reactions are fairly complex. Ascorbic acid is an active inhibitor of browning, but it becomes transformed into dehydro-ascorbic acid, which appears to be an excellent forerunner of browning. As to the inhibiting power of thiourea, it can be assumed that it intervenes as an agent which protects the ascorbic acid against oxidation, just as do cysteine and several other compounds containing the hydrogen sulphide group, which show anti-oxidation properties.

Mr. LAVOLLAY (Professor at the Conservatoire National des Arts-et-Metiers, France) remarked that the anti - oxidation action of thiourea on ascorbic acid is a fact which was established some ten years ago. When thiourea is added to a medium containing ascorbic acid, auto-oxidation and even oxidation of the ascorbic acid catalysed by the enzymes are inhibited to a very great extent. Now, auto-oxidation of ascorbic acid is accompanied by the formation of peroxyde of hydrogen which can react on certain easily oxidable substances in the medium to give rise to coloured products. This explains the fact that the presence of thiourea prevents browning to the extent that browning is due to chromogenous oxidation by the peroxide of hydrogen; in fact, by inhibiting the auto-oxidation of the ascorbic acid, the thiourea opposes the formation of peroxide of hydrogen in the medium. This phenomenon would seem to be similar to the induced oxidation of florizine by ascorbic acid on contact with the air, which has been studied by the speaker in collaboration with Mr. NEUMANN. Experience has shown that when small quantities of ascorbic acid and florizine are added to water with a pH comprised between 7 and 9, the solution quickly turns red on contact with the air. It has been established that what is happening here is an oxidation of the florizine by the peroxide of hydrogen arising out of the auto-oxidation of the ascorbic acid, and that all substances which oppose the auto-oxidation of the ascorbic acid inhibit the turning red of the solution, or, in other words, prevent browning.

However, it is not out of the question that the acid can act in some other manner to bring about phenomena of browning.

Mr. SASZ (Switzerland) remarked that it would perhaps be a mistake always to try to link up the oxidation of a product with the presence or absence of ascorbic acid. Browning phenomena can be noted in tomatoes and citrus fruit juices in spite of the presence of high non-oxidised ascorbic acid contents.

Mr. LEA (United-Kingdom) supported Mr. SASZ' remarks and confirmed that it is not always possible to prevent browning reactions by the quantity of ascorbic acid. Browning phenomena may just as easily occur in media containing a large proportion of ascorbic acid as in the presence of very small quantities of this acid.

SIXTH MEETING

(Friday, October 19 - morning)

AGENDA : Packing.

CHAIRMAN : V.J. DRESCHFELD, Sales Manager, Food Cans, Metal Box Company (United-Kingdom).

PAPERS SUBMITTED :

1. Developments in tinplate technology, paper No.XXXVIII, submitted by the author, E.S. HEDGES, D. Sc., Ph. D., A.R.I.C., F.I.M., Director of Research, Tin Research Institute (United-Kingdom).

2. Developments in tinplate and tinplate container manufacture in the United States during the last twelve years, paper No.XXXIX, by R.H. LUECK, D.Sc., General Manager of Research, American Can Company, and K.W. BRIGHTON, D. Sc., Supervisor, Technical Laboratory, American Can Company, submitted by Berton S. CLARK, Vice-President, American Can Company (United States of America).

3. Developments in the manufacture of canned food containers, paper No. XL, submitted by the author, F. JAKOBSEN, Director, Research Department, Plåtmanufaktur (Sweden).

4. Development of aluminium cans, paper No. XLI, submitted by the author, T. TAARLAND, Chief Chemist, Hermetikkindustriens Laboratorium (Norway).

5. International standardization of tins for processed foodstuffs, paper No.XLII, submitted by the author, G. WESTON, Technical Director, British Standards Institution (United-Kingdom).

SUMMARY OF DISCUSSION

The discussion which followed the submission of these papers covered more particularly :

a) problems of tinplate corrosion;

b) the behaviour of aluminium containers (page 14);

c) progress of the work of international standardization of containers and the attitude with regard thereto of the organizations concerned in the United States and Canada (page 14).

a. Problems of tinplate corrosion

The fact that the causes of certain cases of " swelling " which have occurred in France on canned fruit remain apparently inexplicable led Mr. LAGNEAU (Director of the Union nationale des Fabricants de Conserves de Fruits et de Confitures, France) to ask that some method be contemplated of making more efficient research into the veritable causes of such accidents. He hoped that the characteristics of the base steel would be determined by the steelworks and that it would always be possible to identify the various batches made up so that, when such an accident happens, observations can be made which would serve as a guide for the research.

Mr. HEDGES (Tin Research Institute, United-Kingdom) linked up Mr. LAGNEAU's suggestion with the standardization of tinplate which, as he says, could be of great importance from this point of view both for the container manufacturers and the canning factories, and which should therefore be taken into consideration by the Permanent International Committee on Canned Foods.

Mr. CLARK (Vice-President, American Can Company, United States) mentioned that in his country measures similar to those suggested by Mr. LAGNEAU have been taken with respect to beer containers; but as it is somewhat difficult to obtain the agreement of the iron and steel industry with a view to identifying the products, he felt that the technical departments of the can manufacturers were better qualified to analyse the problems raised and endeavour to ascertain the causes of corrosion.

Finally, Mr. CLARK pointed out that the marks used to identify the surfaces of the tinplate when they are given different thicknesses of tinning may be a means of ascertaining the origin of the material.

Mr. LEWIS (Tin Research Institute, United-Kingdom), considering the quantity of tin available throughout the world, wondered whether the saving of this metal which it is sought to achieve by reducing the thickness of the tinning more and more, is really necessary. He emphasized that world resources in tin are definitely adequate to satisfy consumption and that, as to the future and faced with certain pessimistic forecasts which have been made, it is to be noted, in particular, that all the tin-bearing land is far from having been fully prospected. In Malaya only 10 % has been, and a district which was exploited many, many years ago, like Cornwall, can still produce 10,000 tons of tin metal per annum for a whole century.

Mr. DRESCHFELD (in the Chair, United-Kingdom) pointed out, however, that the price of tin is also largely responsible for the endeavours to make a saving in the weight of the metal used.

Returning to the problems of corrosion properly so - called, Mr. CHEFTEL (Director of the Research Laboratory of the Etablissements J.J. Carnaud et Forges de Basse-Indre, France) would like to emphasise that whatever may be the accuracy of Mr. JAKOBSEN's theory with regard to the period of disintegration of the tin coating, it appears to him that the technical progress made during the last few years has incontestably shown that the quality and properties of the steel are factors predominating, by far, on the role and thickness of the tin coating. He wondered whether, at least theoretically, it would not be possible to achieve, not one atom of tin per square mile, but at least a monomolecular coating of tin on the surface of the iron, provided that the product has a sufficiently high concentration of stannous ions.

In connection with Mr. LAGNEAU's suggestion, Mr. CHEFTEL stated that research work was done from 1921 to 1927 in the United States, on the one hand, and, on the other hand, by the Institut de la Conserve and the Ecole de la Conserve in France before the war.

Series of cans were identified, observations were made, but it was not possible to work back to the veritable reason for the behaviour of the different batches of iron. The problem is not a simple one, he said, because the factors of corrosion arising from the tinplate, as well as from the products contained in the cans are excessively numerous, and others are always being added which were hitherto unknown.

On this subject Mr. CHEFTEL informed the meeting of experiments he is now directing, according to which there would seem to be a new factor of corrosion inherent in certain canned products, which had not yet been suspected and which is nevertheless excessively widespread.

Mr. CHEFTEL proposes to publish the results of these experiments as soon as he has been able to eliminate all doubt as to their applicability.

In conclusion, he urged the exercise of great caution with regard to generalisation and emphasised that elucidation of the causes of corrosion calls for experiments on a really enormous scale.

b. The behaviour of aluminium containers

Before asking Mr. TAARLAND to enlighten him in greater detail as to magnesium and aluminium alloys, Mr. ADAM (Deputy Director, Fruit and Vegetable Preservation Research Station, Campden, United-Kingdom) informed the meeting of his personal experience on this subject. He had noted that the addition of magnesium to the aluminium gave some mechanical advantages - the resistance of the cans to pressure and rough handling was increased - but that, as against this, the number of accidents due to corrosion also increased.

On the other hand, with regard to the 2 S and 3 S alloys, Mr. ADAM had found the 2 S alloy too soft and the strength of the cans made of it too small, but the 3 S alloy appeared satisfactory to him from various points of view.

Mr. TAARLAND regretted that he could not give Mr. ADAM any information on the ground of his own experience in connection with magnesium alloys, as the laboratory tests were made in Norway by the aluminium manufacturers and not by the departments to which he belongs. However, he particularly wanted to point out that the drawbacks noted by Mr. ADAM (corrosion) in the case of magnesium alloys should not be very great, as the cans are always sold varnished.

Mr. BORGSTRÖM (Director, Svenska Institutet for Konserveringsforskning, Sweden) expressed his surprise at the fact that the Stavanger laboratory had noted that the use of aluminium for dairy products had given bad results, when in other countries it is used more especially for those same products. He supposed that when favourable results are achieved it may be that a special alloy or varnish is used. He asked whether any information could be given him on this point.

In this connection, Mr. CHEFTEL (France) explained that aluminium has its place as packing material for canned foodstuffs, but that during the last few years there has been an excessive tendency to recommend it on a commercial scale as being suitable for any product whatever. He was afraid that if this propaganda were persisted in, it might lead to disaster. He added that it must be admitted that aluminium is not suitable for certain products and that one of the drawbacks of its use is certainly the fact that its low mechanical strength makes it necessary to use special machinery for sterilisation, and to take precautions so as not to illtreat the cans too much.

c. International standardization of containers

In connection with paper XLII submitted by Mr. WESTON, Mr. Henry SAINT-LEGER, General Secretary of the International Standardization Organization (ISO) made the following statement :

" I have really very little to add to the excellent report of my friend Mr. WESTON, Technical Director " of the British Standards Institution, Member of ISO for the United-Kingdom, and which is in charge of the " Secretariat of Technical Committee 52 of ISO - Hermetically Sealed Metal Food Containers.

" ISO now has 32 member bodies and its purpose is to co-operate in improving the standard of living of " all peoples throughout the world, wherever they may be living.

" Our Constitution states that ISO can co-operate with other international organizations dealing with " related questions, particularly by undertaking, at their request, studies on standardization projects.

" Moreover, our directives stipulate that a technical Committee may apoint one of its members to en- " sure liaison with other international organizations, after approval by the Council.

" That is our democratic way of pursuing our aim. I am happy to say that this liaison between Technical " Committee 52 of ISO and the Permanent International Committee on Canned Foods has been and will continue " to be very efficient and very constructive.

" I will take this opportunity to give you here the latest news of international standardization:

" The Economic Commission of the United-Nations for Asia and the Far East (E.C.A.F.E.) which has just " finished its work in Bangkok, has stated that it was prepared to assist the nations of Asia and the Far " East by means of standardization, and has decided that this assistance should be given through ISO.

" That is truly, in my opinion, very constructive news, which will help to make the world a better place " to live in."

Mr. WESTON wished to add the following to his paper, so as to show how profitable standardization can be : standardization voluntarily carried out by the paint industry of the United-Kingdom has enabled the number of shapes and sizes of cans used to be reduced from more than 800 to 26; a single manufacturer has

estimated that for only two of his factories, the total saving was of the order of one hundred thousand pounds sterling per annum.

Then, with regard to ISO's relations with other international bodies, Mr. WESTON stated that there are a great many specialised international organizations which, in the course of their work, are invariably led to consider matters of standardization, but whose resolutions, whatever may be their value and the strength which supports them, can only become effective by being transformed into national standards in the various countries. Hence the necessity emphasized by the speaker, of proceeding as the C.I.P.C. has done, that is to say, of establishing relations with ISO and seeing that all resolutions relating to standardization are transmitted to that body so that they can be converted into international standards.

Mr. WESTON having completed his statement, Mr. CHEFTEL (France) would like to know what is the reaction of the parties concerned on the other side of the Atlantic, and more precisely, in the United States, to the proposals which have been adopted by ISO ?

Mr. DRESCHFELD expressed the view that it would be highly regrettable if the representatives of the United States industry, which makes more canned goods than all the European countries together, were to prevent the final success of the work which the C.I.P.C. and ISO Technical Committee 52 have taken in hand so seriously.

For this reason he joins in Mr. CHEFTEL's question, as does also Mr. BACQUIAST (Centre national du Commerce Extérieur, France), who would also like to know why the United States and Canada are not members of this ISO Technical Committee 52 and to obtain some enlightement as to Canada's position with regard to standardization of containers.

Mr. WESTON admitted that ISO Technical Committee 52 is extremely disappointed at not having been able to obtain more active collaboration on the part of the trans-Atlantic countries, but he hoped that by constant negotiations which were being carried on, it would eventually be assured.

Mr. CLARK (United States) did not feel he was in a position to give a precise reply to the questions raised by Messrs. CHEFTEL, DRESCHFELD and BACQUIAST, and did not think his American colleagues were any better able to do so.

Mr. FEIGENBAUM (Food Industries Department, Ministry for Agriculture, Israel) would like to know whether, within the framework of international standardization of containers, the question of the quality of the cans - for instance, resistance to pressure - is being dealt with.

Mr. WESTON replied that this question could only be taken up in the future, because the activity of ISO Technical Committee 52 is at present entirely taken up by the sole question of the standardization of sizes.

With regard to the work of international standardization, Mr. CHEFTEL (France) wished to ensure that there was no misapprehension in the minds of his American friends : on the one hand there is the Permanent International Committee on Canned Foods, a private body which is highly desirous of enjoying the co-operation and assistance of the transatlantic canned food industries and related industries, and , on the other hand, there is the International Standardization Organization, - an official inter-governmental body; Mr. CHEFTEL expressed his surprise that the Americans and Canadians were not participating in the latter's work; whereupon Mr. WESTON added that Canada and the United States take a very active part in ISO's work, and that from this point of view Technical Committee 52 is an exception.

SEVENTH MEETING

(Friday, October 19 - afternoon)

AGENDA : 1. Reports on the Permanent International Committee on Canned Foods (C.I.P.C.).

2. Resolutions of the Congress.

CHAIRMAN : R.V. MANAUT, President of the Permanent International Committee on Canned Foods (C.I.P.C.).

REPORTS SUBMITTED :

1. The past, present and future of the Permanent International Committee on Canned Foods (C.I.P.C.), paper No. XLIII, submitted by the author, R.V. MANAUT, President of the C.I.P.C.

2. Report on the scientific and technical work of the C.I.P.C., paper No.XLIV, submitted by the author, H. CHEFTEL, Chairman of the Scientific Commission of the C.I.P.C.

3. Report on the work of the C.I.P.C. in the economic field, paper No. XLV, submitted by the author, P. PEISSI, General-Secretary of the C.I.P.C.

BRIEF MINUTES OF THE MEETING

The two last-mentioned reports constitute the "Balance Sheet" of the activity of the C.I.P.C., and as such they were submitted by the Chairman for approval by the Congress.

The Congress approved them unanimously. This approval is covered by the first Resolution of the Congress, reproduced in fine (page 17).

After the three above-mentioned reports had been read and in connection therewith, Mr. Morgens JUL, Chief of the Technology Branch, Fisheries Division, Food and Agriculture Organization of the United-Nations (F.A.O.) made a statement on the importance of the work of the C.I.P.C. and the position of the said Com-

mittee with regard to the F.A.O. This statement was followed by suggestions made by Messrs. BORGSTRÖM, Director, Svenska Institutet for Konserveringsforskning (Sweden) and CADBURY, Managing Director, British Canners Ltd. (United-Kingdom), that the work of the C.I.P.C. be extended and a third International Congress on Canned Foods be organised.

The essential passages of these statements and suggestions are reported hereunder.

The Chairman invited the congress members to take the floor and express any comments they wished to make at the end of the 2nd International Congress on Canned Foods.

Mr. JUL felt the time was opportune to express, on behalf of the Food and Agriculture Organization of the United-Nations, all its wishes for the success of the C.I.P.C. and also to its chairman. He would like to congratulate the C.I.P.C. most particularly on having taken the initiative of organizing the 2nd International Congress on Canned Foods and on having succeeded in interesting so many prominent people therein, whose participation is the secret of the success of all international meetings.

Dealing with the respective tasks of the F.A.O. and the C.I.P.C., Mr. JUL asserted that these two bodies do not duplicate each other. The C.I.P.C. is a private association of industrialists, F.A.O. is a governmental institution, and, on both the international and the national level, governmental organizations need profesional organizations representing Industry, to advise and assist them.

As to possible co-operation between the two bodies, Mr. JUL gave the assurance that F.A.O. is ready to collaborate with the C.I.P.C. with regard to a whole series of questions.

As an example of the work done by the C.I.P.C. and likely to be of interest to F.A.O., Mr. JUL mentioned that which had been done in connection with methods of analysis. F.A.O., in turn, would be able to assist the C.I.P.C. with respect to statistics, in view of the facilities which it, as a governmental body, has to obtain information from the most official sources.

Alluding to the progress of the work of C.I.P.C., Mr. JUL emphasized that it is not possible to achieve results quickly, even though each country may admit the utility and even the necessity of a certain international unification in many fields.

Mr. JUL expressed the hope that within the near future the C.I.P.C. would receive greater support in various countries, and, with this end in view, advised it to circulate its publications even more widely, which in many cases are excellent library documents.

Mr. BORGSTRÖM suggested that the C.I.P.C. should create new working committees and, in particular, a Committee on Legislation, which would make a thorough study of the various national laws on canned foods, so as to submit proposals for unification to the different countries; a Committee on Propaganda, with a view to determining the means to be employed vis-à-vis the public so as to develop the consumption of canned foods; a Committee on Nutrition, a Committee on Packing, by reason of the importance of the latter in the field of canned products; a Committee on Equipment, with the task of studying the development of the equipment of the canned foods industry. He also suggested that the C.I.P.C. should increase the number of its Committees in charge of setting up standards product by product.

On the Chairman's proposal, Mr. BORGSTRÖM's suggestions were unanimously adopted by the Congress. They are covered by the 2nd Resolution reproduced in fine (page 17).

Mr. CADBURY drew a parallel between the 1st International Congress on Canned Foods in 1937, which gave birth to the C.I.P.C. and the present Congress, which, it seems to him, will be extending the field of activity of the C.I.P.C.

He read a draft resolution (3rd resolution reproduced in fine) which, on the Chairman's proposal, was unanimously adopted.

RESOLUTIONS OF THE CONGRESS

1st RESOLUTION

" The 2nd International Congress on Canned Foods, after having heard the reports made by Mr. P. PEISSI, Secretary-General, and Mr. CHEFTEL, President of the Scientific Committee of the C.I.P.C., on the work of the C.I.P.C., adopts the said reports."

2nd RESOLUTION

" On motion by Mr. BORGSTRÖM (Sweden), the 2nd International Congress on Canned Foods suggests to the C.I.P.C. that it should extend its field of activity still further, particularly by creating new Committees : Committees on Legislation, Nutrition, Packing, Equipment, Propaganda (selection of arguments to be taken as a basis for the promotion of consumption of canned foods).

" It also suggests that the activity of C.I.P.C. be extended to studying the setting up of standards for individual products, and that new Committees be created for this purpose."

3rd RESOLUTION

" On motion by Mr. CADBURY in the name of the United-Kingdom delegation, the 2nd International Congress on Canned Foods asks the C.I.P.C. to organise a third International Congress in 1956 and, in this connection, requests the said Committee to take up the studies and continue the work inspired by the discussions which have taken place at the Congress during the last few days, with particular emphasis on :

1. the various subjects brought up for research;
2. the improvement and co-ordination of regulations governing international trade in canned foods;
3. propaganda, based on the nutritive and economic value of canned foods, with a view to promoting consumption thereof."